



## TRIP REPORT

Working Group on Biological Weapons Control  
Committee on International Security and Arms Control (CISAC)

Meetings in Moscow and London  
April 18-22, 1994

**Members and Staff of the Working Group:** Joshua Lederberg (chairman), University Professor, The Rockefeller University; Robert Chanock, Laboratory of Infectious Diseases, National Institute of Allergy and Infectious Diseases; Matthew Meselson, Cabot Professor of Natural Sciences, Harvard University; Thomas Monath, Vice President of Research and Development, OraVax; Alexis Shelokov, The Salk Institute, Government Services Division; John Steinbruner, Director, Foreign Policy Studies Program, The Brookings Institution; Jo Husbands, Director, CISAC

**APRIL 18-19** -- Meeting with Counterpart Group, Russian Academy of Sciences (RAS), Shemyakin Institute of Bioorganic Chemistry

**Members and Staff of the Russian Academy of Sciences Counterpart Group:** Rem Petrov (chairman), RAS Vice-President for Life Sciences; Vladimir Bolshakov, Director, Institute of Ecology of Plants and Animals, Ural Branch, RAS; Vadim Ivanov, Director, RAS Shemyakin Institute of Bioorganic Chemistry; Anatoliy Kuntsevich, member, RAS BW Group; ? Mikulin ?, President's Committee on Matters Pertaining to the Chemical and Biological Weapons Convention; Lev Sandakhchiev, Director, Scientific Production Association "Vector;" Evgeniy Sverdlov, Director, RAS Institute of Molecular Genetics; Anatoliy Vorobyov, Head of Chair for Microbiology, Virusology, and Immunology, Sechenov Academy of Medicine; Yuriy Shiyan, Chief Expert and Coordinator, Foreign Relations Department, RAS

The agenda for the meeting with CISAC's counterpart group included four items:

1. Ways to Strengthen the Biological Weapons Convention
2. Problems of the Destruction of Smallpox Virus Collections
3. Ecology of Anthrax in the Sverdlovsk Region
4. Conversion of Defense-Related Facilities

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## **Introductions**

Rem Petrov welcomed the group on behalf of the Russian Academy of Sciences. In his opening remarks, Joshua Lederberg noted that the two groups had worked together over many years. The groups represented a channel to the side of regular diplomacy, but he believed they had helped to increase mutual understanding, leading to a growing convergence of objectives and means. He commented that, as medical experts, no one understood better the threat posed by biological weapons (BW). No one believes that BW would be used between the United States and Russia, but Lederberg noted the paradox that, as this bilateral confidence is increasing, he believes the threat of the use of BW is greater than ever before. The knowledge and technology are widely available, within the means of leaders who may see these weapons as the means to strike at stronger nations, such as Russia and the West. Biological weapons lend themselves to acts of desperation, terrorism, or revenge. The use of chemical weapons in the Iran-Iraq War and the recent bombing of the World Trade Center point up the escalation of violence and of terrorism. It is not very difficult to imagine a world in which any small group with a grievance is willing to use BW to further its goals.

Russia is just as vulnerable to BW as the West, and in this sense, the interests of the U.S. and Russia are absolutely congruent. Lederberg emphasized the need, speaking as medical scientists, to find ways to better collaborate to deal with threats from third parties. Scientists need to work to eliminate any lingering suspicions and misunderstandings that inhibit cooperation. He said that the best way is to work together on common, collaborative projects, for example, to assist the conversion of offensive or defensive research facilities.

Lederberg noted that BW defensive work is essential, and essentially the same as the preparations needed to respond to natural scourges. In many countries, military medicine has played a major role in promoting public health. He saw a great opportunity to focus dual-use research on "exotic" diseases. It is obvious why the military would be concerned with diseases that could threaten troops, but this research also has great potential to benefit global public health. But to achieve this potential, it will be necessary to lay the past to rest.

When the two groups met in the U.S. last May for a planning session, the CISAC group had promised to try to encourage more practical support, including funding, from the United States for such research and for BW-related conversion projects. Nuclear and chemical weapons conversion is being supported, but to date not BW. Lederberg said that he believed the recognition was growing within the U.S. government, although such views were not universally held, that BW conversion and positive public health programs could be linked.

Petrov supported the idea of working groups to focus on specific potential projects, and said his own dream was to see two or three joint projects. If common interests could be identified during the discussions, it would be possible to work toward concrete proposals. He commented that he agreed entirely with the philosophical ground laid out by Lederberg, adding that there was a "conversion of conscience" under way for those whose previous work had involved research related to BW.

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### **Strengthening the Biological Weapons Convention (BWC)**

Steinbruner described the fundamental premises underlying the work that he and Tom Monath had been developing for several years. First, biological weapons represent an example of a new proliferation problem -- the diffusion of the relevant technology means that denial, the basis of past nonproliferation efforts, can no longer be relied upon to achieve control. Second, the Biological Weapons Convention has been politically damaged and needs to be restored. Third, the United States and Russia share very strong common interests in preventing BW proliferation, but will need to cooperate to produce better organization and policy.

The BWC bans offensive research and development, but permits defensive work. This is an extremely hard line to draw, and has been the source of considerable tension in the past. He and Monath were suggesting one scheme to control permitted and banned activities. The scheme would be based on the characteristics of the diseases themselves -- their infectivity, lethality, rate of incubation, and ease of spread. Diseases that rate high on these characteristics would pose significant threats and be especially attractive as potential BW agents. As of now, there is no disease that is at the top of all of these categories -- and Steinbruner noted that it would be in the world's interest to keep that category empty.

The regime he and Monath were proposing would rely primarily on induced disclosure. They proposed a schedule of agents and thresholds for disclosure; above a certain threshold, possession would be prohibited. The standards would be international, so that information about permitted and prohibited activities would be universally available. Researchers would be expected to routinely report work on the agents on the various schedules, with stricter reporting standards for more dangerous agents. The purpose of the schedules would be to permit reasonable research, although work on some agents might require permission from an international body in order for researchers to hold more than a minimum amount.

The fundamental assumption behind this approach is that the only hope for control lies in developing strong norms of disclosure. The United States and Russia could take the lead, but they would soon need to bring the rest of the world along. Steinbruner acknowledged that this type of regime would not address terrorism, but he argued that, by establishing collaboration among the major governments, it would put the world in a better position to address such threats.

Sandakhchiev said that he wanted to offer a personal perspective on the problem of conversion. He suggested that the United States and Russia are in the same boat in the face of a growing danger of BW use by third parties. He said the Russians understood the implications of this threat for the BWC and that he understood the purpose of the ideas presented by Steinbruner and Monath. But he suggested that the basis for discussion should be the threat from third parties, which must not be underestimated. Joint work was needed to build knowledge of how best to respond to these threats.

Sandakhchiev also commented that the issue of disclosure was very sensitive. There

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are contradictions -- disclosing data on the most sensitive agents could aid terrorists. He suggested that data from such research projects should be shared among Russia and NATO but "closed," so as not to reveal dangerous information.

Vorobyov presented his own work on the classification of biological agents and their products. He argued that a scientifically based classification scheme could provide the solution to problems with the BWC. He argued that defensive BW work was necessary, and this would require a program of inspection and control.

Vorobyov proposed a classification scheme, noting that with the large number (3,500+) of pathogens, some means to discriminate the most important for BW was essential. His scheme is not based on biological hazard alone, but also includes features relevant to potential use in weapons. He noted that concern should be given to both natural and artificial agents. He listed eight essential characteristics for distinguishing among the agents; among these were the dose required for infection, the possibility of mass producing the agent, its potential for dissemination, and the absence of available defenses.

Vorobyov suggested that potential BW candidate agents may be divided into three groups (see Attachment #1, Table #1, Russian original and translation).

1. Natural bioagents -- cause massive infection and serious disease in man because they possess many of the eight essential characteristics that he listed (such as small infectious dose, ease of contagion, environmental stability, absence of means for prompt diagnosis, treatment, or prevention).
2. Natural bioagents -- those particularly suited for terrorist rather than military purposes (agents associated with high probability of infection, inapparent "process of infection" (pathogenesis), difficulty of detection, and safety of terrorist operation).
3. Artificial bioagents -- specially produced, tailor-made agents associated with features such as higher virulence and higher environmental stability.

Vorobyov next proposed a system of grading the candidate agents according to a total score for each agent based on points (from 1 to 10) assigned for each of the following 10 cardinal criteria: (1) susceptibility of man to this agent; (2) size of the aerosol infectious dose; (3) contagiousness (index); (4) transmissibility by various routes; (5) stability as aerosol and in environment; (6) type of illness (severity, lethality, duration, etc.); (7) ease of mass manufacturing; (8) possibility of prompt diagnosis; (9) availability of effective treatment; and finally, (10) availability of specific prophylaxis (see Attachment #1, Table #2, Russian original and translation).

Vorobyov finally presented the BW candidate agents grouped by their scores in relation to the 10 cardinal criteria (see Attachment #1, Table #3, Russian original and translation). Group I included agents with scores from 15-26 -- those most likely to be used for BW; Group II had scores from 10-14 -- possibly useful as BW; and Group III had scores under 10 -- probably not useful as BW.

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Group I (score 15-26): smallpox (26); plague (23); anthrax (21); botulism (21); VEE (20); tularemia (20); Q fever (20); Marburg (18); influenza (17); melioidosis (17); rickettsial typhus (15)

Group II (score 10-14): brucellosis (13); Japanese encephalitis (13); yellow fever (13); cholera (13); tetanus (13); diphtheria (12)

Group III (score less than 10): rabies (8); typhoid fever (7); dysentery (6); staphylococcus (5); HIV (5).

Petrov commented that he would be particularly interested in joint work on the classification of "nonnatural" agents, that is, the products of genetic engineering.

In response to Sandakhchiev's earlier remarks, Steinbruner commented that he did not mean to suggest that disclosure would include publication. He foresaw the possibility of governments and laboratories informing one another of their work without broad public disclosure, and cited the U.S. Securities and Exchange Commission as an example of an organization that was able to gather and control large amounts of very sensitive financial data. Sandakhchiev replied that such a regime must be developed in the framework of U.S.-Russian cooperation. The military establishments on both sides would have to be involved, and means found to preserve necessary national secrecy. Means would have to be found to provide clear and complete knowledge of whether an agent has BW potential, what measures could be taken to deal with it, and the best means of protection against it. There should not be restrictions or bans on research on sensitive materials.

Lederberg commented that full disclosure should be the objective, which would be approached step-by-step. Joint work on specific, defined projects could build confidence toward the eventual goal. He expressed concern for the paradox that important biomedical research might be a candidate for a publication ban, and suggested that the "cat was already out of the bag" as far as knowledge of most basic BW agents and technology.

Lederberg raised the issue of what the mechanisms of enforcement might be, commenting that he believed the world's silence in response to the Iraqi use of CW would come back to haunt us. He saw the primary objective as raising biomedical consciousness about how heavy a price we will all pay if the use of BW becomes acceptable. This leads naturally to the issue of enforcement, which requires standards to define what is and what is not permissible. Ideas such as Vorobyov's and Steinbruner's and Monath's provide such standards. It will be very hard to gain third party adherence, but the effort must be made. Scientists need to keep reinforcing the principle, mostly to their own governments, but also to support an international role. Eventually we will have to consider enforcement against third parties; we know there are active programs in several countries.

Steinbruner commented that if there is to be aggressive enforcement action in the future, there will need to be much clearer standards, and a record established about what is permissible. He said he was fairly hopeful, since he believed that BW provoked a stronger public response than CW, and this made enforcement action more conceivable.

Vorobyov said that in Russia diseases were classified on the basis of their danger and

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their ease of dissemination to people. The four main categories are:

1. pathogens causing critical/lethal diseases, of which an example would be the AIDS virus;
2. widely spread infectious diseases;
3. widely spread diseases that are more readily controlled; and
4. rare, exotic diseases.

He said that his BW classification exercise had been done independently of this and other public health classification schemes, and had added technical and economic considerations, and also the possibility of prophylactic responses.

Steinbruner responded that his scheme was based on prevailing public health standards. In response to a question from Lederberg about regulation, he said that they had not addressed the problem in this presentation, but that he imagined it would involve the use of sanctions, which could be quite powerful.

Monath added that it would be important to clarify permitted and banned activities. One clear issue is scale. Another is weaponization-related activities, which would require careful regulation. Aerosol experimentation poses serious difficulties and he suggested the groups should discuss the issue in greater depth.

Vorobyov agreed that the aerosol issue was difficult; for example, some vaccines are developed to protect against aerosol dissemination, which means one must know about aerosols. He suggested that one could eliminate a large number of agents from concern, and should do so in order to concentrate on the most dangerous ones. He said he was skeptical of scale as a criterion, since, for example, antitoxins are developed by denaturing huge amounts of toxins. He agreed with Steinbruner, however, on the need for regulation.

Lederberg reiterated his concern that vital biomedical research should not be hampered. The nature of the institutions involved might be one way to distinguish, although no one should be totally free of reporting requirements. He suggested that perhaps someone from an international organization could be added to the normal oversight boards that govern biomedical research programs. He said he was not certain the military establishments would agree; he has been arguing for civilian oversight boards in the U.S. and the military has not yet agreed.

Meselson said there are two characteristics of the BW problem that distinguish it from other arms control problems and which have important implications for policy. First, nearly every country and perhaps some private groups already have access to the information and the capability. Second, there has not been any use of BW in the post-World War II period. These factors suggest that efforts should concentrate on attitudes and incentives. What can be done to combat the belief that one should have BW because others do, or that BW is important because others accord it prestige or respect, even if out of fear? He added that some information should be kept quiet, since sensationalizing it could tempt people's interest. The media are prone to reporting BW matters in lurid terms. This adds to the importance of

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sober, factual information and discussion of all aspects of the subject, not only technical aspects but also arms control aspects and threat assessment.

Kuntsevich commented that any weapon has a life cycle, and that it was necessary to single out the elements to regulate within that cycle. Here one touches the issue of confidence in bilateral mechanisms. It is necessary not to interfere with beneficial technologies. As the result of a trilateral agreement among the U.S., the U.K., and Russia, there have been a series of visits to facilities in the three countries. Three facilities in the U.S., five in Russia, and one in England have been visited so far. From April 25-30, experts from the three countries will meet to exchange information on the results of the inspections. This activity will give useful experience on how to provide confidence and how to protect sensitive, proprietary information. Regarding aerosols, some activities would be likely to raise suspicions, for example, a large aerosol chamber to hold a tank or vehicle. He voiced his hope that joint projects will emerge.

In response to Lederberg's suggestion, Chanock commented that it would be necessary to find ways to integrate information from various review boards, and this would require a certain mindset that was able to see the larger context. He said he was more worried about desperate individuals, and that emphasis should be given to those agents with the potential to cause pandemics. Nations and international organizations should be prepared for more than just sanctions; there should be real, severe punishments. Defensive preparations should also be made.

Ivanov asked whether, if the two groups could agree on a classification scheme, and if they could formulate and agree on rules, could this scheme have any impact on policy? Lederberg and Petrov responded that the meetings were private, with no joint statements or press announcements. Lederberg added that the CISAC group had good ties within the U.S. government, so that ideas could at least be brought to the attention of policy makers.

Lederberg commented that the groups must be careful not to imply the possibility of verification in a formal sense, since biological research involves the ultimate dual-use technology.

### Destruction of Smallpox Virus Collections

Sandakhchiev reported that the issue of whether the two remaining collections of smallpox virus in the U.S. and Russia should be destroyed as earlier planned had been discussed in the Academy of Medical Sciences and other forums. He promised to give Lederberg copies of all these materials for the record. He reported that most Russian scientists are in no hurry to destroy the collections. Even if destruction goes forward, there should be some further work in advance of that time. The Ministry of Health now has the lead on making the decision about what Russia will do.

He then reported that scientists from his institute had been doing "archeo-virology" on bodies, most about 100 years old, found in the permafrost. The burial sites lay in an area

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that is being explored for oil and natural gas, and the Russian government was concerned about threats of infection from the old graves. Twelve burial sites have been found to date. Several of the bodies studied so far were of victims of smallpox. He suggested that all the work on these bodies should be handled under an open regime, with appropriate transparency, and said that he had brought proposals for further, joint work. (Sandakhchiev presented slides, but also gave Lederberg a copy of a video that had been made of the excavations and subsequent research.)

Chanock commented that these discoveries provided a wonderful opportunity to compare old and new strains of diseases. He added how important it would be if a victim of the 1918-19 flu epidemic could be found. Lederberg also commented on the importance of the work and said he hoped that some specimens would be preserved for future research, when technology may be further improved.

Vorobyov suggested several steps for an eventual destruction campaign for the remaining collections.

1. Joint Russian-American commissions would be established to carry out simultaneous destruction under WHO supervision.
2. Continuing preservation or research with strains would be considered an act of international terrorism.
3. Efforts would be made to take account of all fragments so that appropriate research could be undertaken.

Like Sandakhchiev he supported some preliminary research prior to destruction. He also suggested the need for a safer vaccine.

Lederberg commented that the U.S. group was not unanimous about destruction or preservation. He had initially supported destruction because he perceived it would further U.S. and Russian confidence-building. Now he had become strongly opposed, and supported active, joint management of the collections.

Monath commented that animal models will soon be available, and that vaccinia virus vector vaccines were now going into human trials. He expressed concern that controls were needed on these trials.

Vorobyov commented that the different views were strongly held, and that it was not worthwhile to try to come to a consensus among the group. Plans should be made to cover both the destruction and the preservation of the collections. He argued that the collections should not be destroyed until there was confidence that the genome has been correctly mapped, and said there were hints that some of the sequencing could be in error. He argued that it would be important to preserve existing and relevant knowledge and skills, whichever decision is made.

Lederberg commented that the destruction is a matter of international interest, not just bilateral. The U.S. and Russia need to reassure other countries of their good faith. He asked what a control regime for smallpox might look like.



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Steinbruner responded that there might be ideas from the current planning for the storage and disposition of fissile materials. For example, tags and seals that could be queried remotely to reassure about their integrity might prove useful. These offered the possibility of periodic or continuous monitoring. Vorobyov commented that any regime should be a joint Russian-American one, with WHO participation.

Lederberg commented on the absence of a formal legal framework to support an international decision on destruction. There is no certainty that all stocks of smallpox apart from those declared in Russia and Atlanta have been destroyed in every country. Nor is their retention a statutory crime under either domestic or international law. If destruction is to be carried out it should be within a formal legal regime that has not, until now, been legislated.

Monath suggested that a broader context was necessary. There are other viruses on the edge of extinction, and an international regime is needed to provide a way to hold remaining stocks. Meselson commented that it could be important to be able to track where a strain came from, and that DNA sequence information would be useful for this purpose.

### **The Ecology of Anthrax in the Sverdlovsk Region**

Meselson presented the results of the research that he and his colleagues, including Alex Shelokov, had been doing on the epidemiology of the anthrax outbreak in Sverdlovsk in 1979. He began seeking permission to go to Sverdlovsk in 1983 and was finally able to go in 1992 and again in 1993. The results of the research have been accepted for publication in Nature and are due out in the late spring or early summer.

Meselson listed the sources of information they had used to locate victims and survivors.

- 1) Names and residence addresses were obtained from the list of 68 persons who died whose families are eligible for a government pension as a result of the outbreak.
- 2) Systematic interviews with friends and relatives of those who died, with survivors, and with owners of sheep that died.
- 3) Information from grave markers, since almost all the victims were buried in a specific section of one cemetery.
- 4) Notes from pathologists who worked at the hospital to which victims were taken, which included data about onset and death.
- 5) Informal hospital notes regarding those screened for possible infection.

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For 66 of the cases, Meselson and his colleagues were able to locate both home and workplace. With only a few exceptions, all of the victims lived or worked (or had jobs that could have put them in) a path to the southeast of a military microbiology facility known as Compound-19. The onset data do not provide evidence of more than one release. Wind data (the airport in Sverdlovsk is part of the World Meteorological Organization reporting network) show one day in which winds ran in a direction parallel with the path of cases. The data on livestock deaths in the villages outside Sverdlovsk fall on the same long elliptical path out to a distance of 50 kilometers from Compound-19, strongly suggesting that the release came from the military facility.

Meselson stressed that there is no information available on what caused the release, on what the exact strain was, and on the size of the release. The Russian general currently in charge of BW defenses has stated to the press and in private conversation that research on anthrax involving the use of an aerosol chamber was taking place at Compound-19 in the late 1970s and that a vaccine was under development.

Meselson used a standard Gaussian model of dispersal to draw contours of constant dosage, but this does not tell the size of the dose. There are no adequate human data to help estimate the dose-response. With the models and knowledge available from experiments with monkeys, Meselson estimates that the release was somewhere between one milligram and one gram of aerosol anthrax spores. The total amount being worked on when the release occurred could have been greater.

Lederberg commented that, using other data about population density, and assuming that the release was 1 gram, one can derive a figure of 100,000 cases per kilogram of material, a rate far above the lethality of nuclear weapons.

Petrov asked why so many cases occurred among those who worked at a ceramics factory near the compound. Meselson responded that there were about 2,000 workers at the ceramics factory, giving it a high population density, substantially higher than the daytime population density in the residential area north of the ceramics factory. Petrov asked if there were any other explanation that fit the information that Meselson had acquired, such as the release coming from the ceramics factory. Meselson responded that this would mean the wind blew in two directions only, and that these differed by almost exactly 180 degrees. He said those conditions were very unlikely and not in agreement with meteorological information.

Bolshakov offered comments on Meselson's presentation, first noting that there was a long history of anthrax cases in the Urals region among both animals and humans. He said that his institute was in the same district of Sverdlovsk and that many of his employees lived in that area, so there had been considerable interest in the epidemic. Bolshakov said that there appeared to be some contradictions in the results Meselson reported, noting that there had been an official Soviet government explanation blaming the outbreak on tainted meat. Bolshakov said that recently a shipment of anthrax-tainted meat from Kazakhstan had been discovered in Sverdlovsk. In this case, it was discovered in time and destroyed. Bolshakov said this was not to say that he believed the tainted meat explanation, but it still should be

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examined.

He also commented that, in 1979, in this and another district, houses and buildings had been washed down, and a considerable amount of ground paved over, which would be consistent with an airborne outbreak rather than ingestion.

Bolshakov said that, if the source of the epidemic were an airborne release, then it might have come from other sources. For example, he said, there was clay within the ceramics factory from deposits that is transported by truck to Sverdlovsk for use in the factory. These deposits are said to have been burial sites in the past for animals that died of anthrax. It is possible that excavations of these deposits could have caused a release. He also noted the case of a truck driver who had been outside the zone Meselson identified. The driver had been hauling clay and when he returned home, he washed down his truck. This person later contracted anthrax and died.

Bolshakov also questioned why there were not more cases among the reservists who were doing their training in a camp (Compound-32) next to Compound-19. Some of these reservists were from the Urals branch of the Russian Academy and Bolshakov had talked with many of them, who reported nothing unusual during the time Meselson's research had pinpointed as the likely release date. Finally, he also questioned why there were no cases of wild animal deaths from anthrax, nor cases among domestic animals in the neighborhood rather than simply in the villages outside Sverdlovsk. For example, there were large flocks of crows who lived off wastes from the meat processing plant nearby and moved between there and the residential neighborhoods. Why were there no recorded cases among these birds?

Bolshakov summarized his comments by saying that what happened in Sverdlovsk was primarily of historical interest, rather than a current concern. He noted that at the planning meeting in May 1993 Lederberg had said that each side has military secrets, and it will be up to the military to reveal the truth. Some answers must thus await this greater openness.

Vorobyov commented on how impressed he was with Meselson's presentation, noting that this was the first time he had heard that explanation of the epidemic. He said that anthrax was a very serious BW pathogen, but smallpox is even more dangerous -- what if that had been the agent involved? He commented that there were other explanations for the Sverdlovsk epidemic, and said that he did not think the meteorological evidence was completely persuasive. He also noted that the tainted meat explanation needed to be examined as thoroughly as the alternative Meselson and his colleagues proposed. Vorobyov asked if there was an explanation for why there were so few animal cases in the areas where human cases of anthrax had occurred.

Vorobyov offered a cautionary tale about fixing blame too soon. In Leningrad a biological factory that produced a yeast protein was blamed for a massive outbreak of allergic diseases in the surrounding area. Many experts studied the situation, many precautions were taken, and finally the decision was made to close the factory. But the outbreaks of disease still occurred.

Shelokov, who visited Sverdlovsk with Meselson in 1992, commented that this

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presentation built upon earlier research with samples preserved from some of the victims, which showed that the anthrax outbreak was the result of inhalation rather than ingestion. The results of this pathoanatomic work have been published in both Russia and the United States.

Meselson noted that there had been three articles by Russians pathologists in Arkhiv Patologii in Russia and an article summarizing their work in the Proceedings of the National Academy of Sciences in the U.S. Meselson said that he had initially considered the tainted meat hypothesis to be plausible, but was no longer able to do so. He said he would welcome an alternative hypothesis from his Russian colleagues that would explain the evidence equally well, but knew of none.

Petrov commented that he no longer accepted the tainted meat explanation, but that the contaminated clay deposits might be plausible. He suggested that perhaps joint research might be undertaken on burial places in permafrost regions and in zones where anthrax cases occurred regularly. He suggested that the Nature article should not present the findings as final conclusions, but rather as "the most plausible conclusion."

Lederberg asked how sure people were that this was ordinary anthrax, or whether it might be a different or super-strain. The only conclusive way to resolve this question would be to recover the strain involved. The original investigators who worked in Compound-19 might provide the strain, but there could be obvious credibility problems. One could try genetic work from samples -- "do a Jurassic Park" -- and work of this sort is being attempted in other areas. Or one could try to recover organisms from the environment. The odds against success would be very long, but he was encouraged by the fact that substantial areas had been paved over right after the epidemic. It should also be relatively easy to test the clay deposits Bolshakov had mentioned, since the concentrations required to cause an outbreak of this kind would be so high. Investigations such as these would not require the cooperation of the military, and it seems unlikely there would be an attempt to block such research. He added that correlations between current and past samples could be useful.

In response to a question from Petrov about whether they had had access to microbe cultures, Meselson said that they were told cultures were taken, but that they did not discover where those samples had been taken. Shelokov added that they were told there had been positive cultures, but repeated that the team did not discover where the cultures were sent. Nor did they find out what became of the blood samples drawn from known and suspected victims and others serologically screened. He suggested that perhaps some of the Russians might be able to help find the missing samples or at least what had happened to them. He also added that they were told that before applying asphalt the streets were treated with a disinfectant, which may make recovery of the spores more difficult.

Steinbruner commented that this was not just a medical and scientific problem, but also a political problem because of the history of BW issues. He said that a residual doubt remains about what actually happened, but he warned that when the research findings are published, that doubt will not be part of the political response. The political process will accept that there was a military release, and that there was a deliberate cover-up. The

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conclusions will be highly prejudicial. This means that any alternative explanation must be investigated quickly, credibly, and jointly. He saw this as a possibility for important joint work as well as a problem, but wanted to stress the time constraints imposed by the pending publication of the article.

Lederberg reminded the group that CISAC had been given a first-hand account of the anthrax epidemic, with the now-discredited explanation, during a previous Working Group meeting at the Shemyakin Institute several years ago. He nevertheless believed that it is possible to get past the idea of a continuing cover-up. An enormous amount could be gained from joint research. He also noted that there must be an effect on Russian domestic politics from the revelations, so there was a political as well as a scientific interest in further research. He said he personally was not concerned with past history but did see an urgent scientific interest.

Petrov commented that he thought that, no matter what the source of the strain, it would be very important to know where the strain is at the present moment.

Lederberg asked if there had been any formal request -- or any chance of one -- from the Ministry of Health to the Russian Academy to investigate this problem. Petrov replied that the Russian Academy had never historically dealt with pathogenic organisms and diseases, so there was no appropriate laboratory or institute within the RAS. He thought the Academy of Medical Sciences might have appropriate capabilities. The Ministry of Health does have an applied, anti-epidemic service, but in the past their work was considered confidential, if not secret.

In response to a comment from Monath that one could probably get conclusive evidence from the bodies of the victims, Meselson responded that the bodies had been buried with chlorinated lime. Meselson said that he thought there was a chance the first victims were not buried this way, but Shelokov said he believed those bodies were moved and reburied with chlorinated lime later. It was not possible to find spores in the tissue samples. The research team had not found any evidence of what might remain of veterinary samples. Meselson had collected 50 soil samples, but these have not yet been analyzed.

Petrov said that he thought joint research could be productive, but that it should deal with more general problems related to anthrax. The research should not be politically motivated, and not be a detective investigation. The Russian Academy could be involved only if the purpose of the research was scientific; current domestic politics in Russia would not permit their participation in any other sort of investigation.

Sverdlov agreed, suggesting that there could be a genome study of dangerous pathogens, of which anthrax could be a part. His institute had extensive experience with DNA fingerprinting that could be useful for such work. Petrov commented that Sverdlov ran an important institute that, for example, conducted the recent genetic research to authenticate the remains of the Russian royal family. Meselson commented that his own research included DNA sequencing, so he was interested in Sverdlov's ideas.

Vorobyov commented that he supported the idea that was emerging for joint research on the "ecology of anthrax on the Russian territory." Such research should be above politics

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and not concentrate solely on Sverdlovsk. He suggested that the Institute of Epidemiology of the Academy of Medical Sciences, headed by Pokrovsky, might be a good participant in such research, as well as other institutes of his academy. His academy had recently elected a new corresponding member, B. Cherkasskyi, who is an expert on anthrax. Vorobyov suggested that the military could and should be included in such a project.

Lederberg commented that he was very pleased with the project ideas that were emerging. Meselson added that a "catalogue" of the sort Sverdlov was proposing could be important for science, for arms control, and for policing compliance.

### **Conversion of BW-Related Research Facilities**

Lederberg began the discussion by saying that there were a number of possible areas for conversion activity that would serve public health goals. One would be the rehabilitation of vaccine production for domestic purposes in the former Soviet Union. Although there has been a good deal of motion, he said he did not expect much to come from the U.S. private sector. The pharmaceutical industry in the U.S. has been the target of substantial criticism in the health care reform debate, and is suffering significant economic repercussions. The initial efforts were made in good faith, he believed, but changed circumstances were making it impossible to deliver on the hopes. By contrast, he said he thought various parts of the U.S. government were increasingly interested in assisting in a marriage of public health and BW conversion.

Lederberg said he saw a number of areas for potential cooperation. One would be scientist-to-scientist collaborations to do research on various diseases. Another might be support for public health planning, perhaps accompanied by some funding and intensive technical assistance. During its visit, the CISAC Working Group was very interested in identifying needs, problems of quality and standards, and a good sense of the current situation.

Petrov responded that vaccines were the responsibility of the Ministry of Health, so that portion of the problem would not be appropriate to the Russian Academy group. Research on new vaccines would be appropriate, however, and of great interest to the RAS institutes.

Sandakhchiev described the experiences of his laboratory, which had been a major scientific research complex funded primarily by the Ministry of Defense and is now an association, with attempts at conversion. The "Vector" complex had been involved in developing diagnostic kits, prophylactic measures, and other research on exotic diseases. He noted that his facilities are not on the same scale as the big medical establishments for civilian production, and that he believed his association and organizations like it faced different conversion problems. In principle, scientists who work with infectious diseases could quickly transform their work to applied public health problems. But the real life situation was not very promising. In 1989, 95% of Vector's work came from the Ministry

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of Defense; today their MOD funding is down to 5% of the 1989 level.

Filling the shortfall is very difficult. His association is pursuing grants and other governmental projects, but these are not enough. For example, the Soros and Hughes Foundations and others are making important contributions, but his scientists are at a disadvantage because in the past their publications were restricted. They have submitted proposals to the International Science and Technology Center (ISTC), for example, for a project to run cholera vaccine trials in cooperation with WHO and the Institute of World Trade. The ISTC is supposed to support all types of conversion, but Sandakhchiev said it is clearly giving priority to nuclear and chemical weapons.

For several years, Vector has been working to transform itself into a pharmaceutical company that would be able to reach a level of sales that would make it self-financing. The Russian government has approved this conversion plan, and implementation has begun. But scarce resources and inflation make it difficult to implement the plan efficiently. Vector's goal is to provide 30% of all the Russian (FSU?) needs for Hepatitis A, B, and C and AIDS diagnostics, and Alpha-2 interferon. They will begin working on a Hepatitis B vaccine on the basis of their experience with smallpox, measles, and Hepatitis A vaccines.

Vector had had a series of contacts with Merck about possible joint ventures. Studies had been done of potential scientific and production cooperation on new medicines, screening and diagnostics, and vaccine production (especially Hepatitis B, measles, mumps, and rubella). The process had been very friendly until the time arrived to achieve some definite results, when two problems arose. The first was the low prices and limited public funds, which made the Russian consumer market unattractive. The second was the unsettled political situation in Russia, which made the company reluctant to invest. Protection from the U.S. government for the investments of American firms was needed, but Sandakhchiev said he believed that the U.S. government was discouraging American companies from cooperating with former BW facilities such as his.

Mikulin (sp.??) commented that conversion was not a direct responsibility of the President's Committee, but that it felt an obligation to try to assist the process. More generally, he said that new articles prohibiting BW research had been added to the Russian criminal code, and that a control commission had been established with responsibility for monitoring military and scientific policy. Export controls have also been established.

As part of the trilateral agreement reached by the United States, Russia, and the United Kingdom, Russian had made the commitment to open former BW research facilities to Western inspection, just as Russian inspectors would examine U.S. and British facilities. This process has begun and will continue, as one essential part of resolving lingering concerns and doubts.

Vorobyov said that it was necessary to speak not just of converting facilities, but also of intellectual conversion. The moral aspects of conversion are very important, since two generations of scientists have been conditioned to the idea that BW research was acceptable. It is vital to turn the attention of the scientific community to urgent problems of public health.

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He said he was not sure what groups such as this could accomplish, nor was he certain what other countries have BW capabilities. He had seen recent press reports that BW activities are still continuing in Russia, but was not able to comment on them.

Monath addressed the issue of how to preserve the expertise on dangerous diseases acquired in biowarfare research for work on these same diseases for the cause of international public health. There is no commercial market for such diagnostics or vaccines, but there is an urgent public health need. It is usually within the province of the government to support such research, rather than the commercial sector. He argued that the people and facilities accumulated in Russia for BW-related research should be kept together and turned into a capability for monitoring and surveillance for global public health.

The positive benefits to be extracted from the expertise of military medicine should not be lost. For example, a new hantavirus variant recently emerged in the U.S.; Russian virologists are leading experts on hantavirus, having extensively studied all aspects of hemorrhagic fevers with renal syndrome. Tick-borne encephalitis is another example of Russian excellence in virus research. Russian researchers' experience could be of great assistance to the West, and joint research might yield new breakthroughs. Diagnostic test kits, vaccines, and antiviral drugs are among the potential fruits of cooperation, but probably will not materialize if the problems of conversion are left solely to the commercial sector.

Ivanov commented on the need for broad contact and cooperative work to encourage confidence. He saw particular promise in work on new vaccines, and perhaps in cooperative work on one or more of the dangerous agents the group had been discussing. For the Russian side, however, the most important issue was financing.

Lederberg summarized what he saw as some of the common understandings emerging from the discussions. Production for BW purposes is at the heart of dual use problems and the situation is irremediable. Since capabilities are so easy to acquire, the problem is how to address motives and intentions. Some states are unlikely to go to war, but when war occurs, the temptation is strong to use any means to achieve victory. Preventing the use of BW in the future will require building a strong world order -- and creating the fear of stern reprisals. There has been no major use of BW in recent years, but there will never be perfect assurances that it will not happen. Continuing advances in biotechnology will continue to pose new risks. Concrete plans need to be made, to deal with both commonplace and new, exotic diseases.

Monath commented that he had just attended a WHO conference, which is considering adding hemorrhagic fevers to a new international vaccine production program. If this happens, it would give a formal structure and funding possibilities for the type of work he was suggesting.

Meselson said that it was necessary to gain a better understanding of American and Russian capabilities in anthrax research. He still felt the need to identify real experts, and assay the intellectual resources available. He suggested starting with a small conference of experts, plus some high-level outside observers. Shelokov commented that one useful place to begin was with the names and institutes supplied earlier by Vorobyov.



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Chanock said he wanted to suggest a completely different approach. He suggested building on recent research advances to mobilize work on antibodies for prophylaxis. Using products of the body's immune responses would offer passive protection rather than the active measures traditionally used. There were very encouraging reports from Argentina that polyclonal human antibodies present in convalescent phase sera, administered up to 11 days after the onset of Argentine hemorrhagic fever had resulted in recovery. In research at the National Institutes of Health, FABs alone have been successful in completely resolving respiratory syncytial virus infection in mice. This advance in therapeutic research rests on the use of human combinatorial libraries to produce and identify virus-specific antibodies with high-binding affinity.

Similar materials should be produced for the most dangerous agents in order to be in a position to respond quickly to the threat of disease. This is a long-term program that could involve many scientists in the U.S. and Russia. A key advantage of such work is that it is not threatening, since it has only defensive and therapeutic applications.

He proposed an initial cooperative program that would bring one or two scientists from Russia with research experience with hantavirus or other diseases to work in the United States, where the expertise on this use of antibodies and the new techniques to apply them, resides. Sverdlov responded that scientists were familiar with such work, that libraries should be readily available, so that such work appeared promising.

Steinbruner said that he had heard at least three possible cooperative projects in addition to the new idea from Chanock. One would be work on hemorrhagic fevers, a second on anthrax, and a third on refining the classification of organisms. He said that each seemed to be practical and achievable and that he thought prospects for finding funding to support the work would be good.

Sandakhchiev said that there had been good cooperation between Russian and American scientists on natural smallpox, but that the limited resources available had stopped the work. He thought that it would be valuable to build on areas where substantial work exists, and would be happy to see support found for such work. A very important new U.S.-Russian agreement for cooperation in natural sciences had been signed in December so there was no need to create new mechanisms. The task was to make use of what was available.

He also said that he believed substantial cooperative work relevant to Chanock's idea was already under way, on which new projects could be built.

Monath said that he believed the groups needed to focus on specific targets that fall clearly within the realm of biowarfare. Tick-borne encephalitis is an example. Vaccines have been developed in Eastern Europe, but their value is questionable. The kind of passive protection suggested by Chanock would be a great boon and would find a market. He particularly supported cooperative work on hantavirus, whose mode of transmission needs to be far better understood.

Petrov emphasized the need for the Russian Academy to show real progress and results. He saw four potential projects, similar to those outlined by Steinbruner. Sverdlov, Meselson, and Bolshakov clearly shared interests in work on anthrax. Vorobyov could work

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with Steinbruner and Monath on refining the classification of organisms. Chanock's idea was exciting, but a potential Russian partner would have to be identified. Monath's ideas for work on international public health monitoring and surveillance seemed to fit well with Sandakhchiev's interests.

Mikulin (sp.??) said that it was paradoxical that there has been real progress toward cooperation on nuclear and chemical weapons demilitarization. For CW, his commission acts as a genuine mediator and coordinator. He suggested that the commission, which has excellent contacts in the Ministry of Defense, might be of assistance in moving a number of these projects forward.

NOTE: The meeting adjourned with the next steps to be made by contacts among individual scientists and with plans for a next meeting to be coordinated between Lederberg and Petrov.

**APRIL 20** -- Meeting with Valeriy Menshikov, member of the Council on Ecological Security, and Vladimir Iakimets, Senior Researcher at the RAS Institute for Systems Studies, and Scientific Advisor to "Nevada-Semipalatinsk." (from the CISAC group -- Joshua Lederberg, Matthew Meselson, Alexis Shelokov, John Steinbruner, and Jo Husbands)

Menshikov introduced himself as the former Deputy Chair of the Russian Supreme Soviet Committee on Ecology. He is now a member of interagency Commission on Ecological Security, chaired by Alexei Yablokov, which provides advice to the Russian National Security Council. His academic field is spectral analytical physics, but he has been a full-time legislator for the past five years. Among his particular concerns are nuclear testing and chemical weapons destruction.

He explained that a new Center of Ecological Research and Policy had just been established, headed by Yablokov with a 12-person staff. This is a non-governmental center that will be doing policy studies for the highest levels of the Russian government.

Iakimets said that he had been involved in developing computer models of complex ecological systems and in preparing an international report for "Nevada-Semipalatinsk." He was also very involved in the NGO summit on the Comprehensive Test Ban, and had recently been in the United States talking with other NGO representatives.

Menshikov said that the Commission on Ecological Security is one of ten departments of the National Security Council, each of which is concerned with a different aspect of security. For example, there is another commission devoted to economic security. He said that President Yeltsin had eliminated his personal advisors in December, so that Yablokov no longer served in the Kremlin as Yeltsin's environmental advisor.

Menshikov said that the Russians have come to appreciate the value of NGOs, which is why they have established the new Center to provide independent research and analysis.

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The Center's first publication was on the history, policy, and ecology of chemical weapons. The second, on chemical contamination and human health, has been translated into English by the Natural Resources Defense Council. Their third publication, which deals with the history, policy, and ecology of plutonium, will be ready in May. Iakimets added that the plutonium report would be comparable in approach to the one released last fall by the Congressional Office of Technology Assessment in the U.S. The next project will be a study of Arctic security.

In the old parliament, Menshikov was in charge of the debate on CW destruction. He has also participated in the discussions of the issue in the new Duma. This a very hot debate, with strongly opposed views. He said that the problems of implementation have created opposition to ratification of the Chemical Weapons Convention (CWC).

In the Duma, both the Ecology Committee and the International Affairs Committee have jurisdiction over the CWC. Menshikov commented that Zhirinovsky is opposing the CWC and has stated that he believes Russia should have chemical weapons. Ratification of the convention will require a simple majority of 51%.

Lederberg commented that he had not been deeply engaged in the CWC discussions in the United States, but noted that the U.S. chemical industry supports the CWC.

Meselson asked Menshikov if the statement attributed to him by the Washington Times that the Russians had had stocks of chemical weapons larger than the 40,000 tons they had officially declared, and had therefore been secretly destroying them to meet the declaration, was true.

Menshikov replied that there had been some process of "tuning" to reach the 40,000 level. In the last few years, there had been some destruction of chemical agents by the military and this might be the source of the report. There are also debates in Russia about the real size of the stocks. He said he believes that right now the number is close to 40,000 tons on military bases, but there may be other agents stored off-site. It is very important to get an accurate baseline for treaty implementation.

Menshikov said that, when he was deputy committee chairman in the old parliament, he had asked the military for information but received nothing. The military had declared it held 40,000 tons in January 1993, but he knew that destruction took place all year without inspection, so he assumed the initial stocks were larger. In the March 1994 Duma discussion, the military declared that it held 40,000 tons now. Menshikov said he thought it would be dangerous for the military to lie to the Duma, so that the 40,000 tons figure should be believed.

He also said he had proposed a joint expert commission on chemical weapons that would be similar to the presidential commission on radiological dumping. Kuntsevich had said he would establish such a commission as part of his work, but it had not happened during his tenure.

Meselson commented that the U.S. was also destroying stocks of chemical munitions but that was part of a conscious policy choice to get the destruction process under way. Meselson also asked about a statement attributed to Menshikov that the Russians were

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destroying adamsite; Menshikov confirmed this. Meselson commented that neither the U.S. nor Russia had declared that it held stocks of adamsite.

Lederberg asked from whom Yeltsin received scientific advice, especially since the creation of the Kuntsevich commission was the result of his discovery that he had been deceived about the true state of the BW and CW programs in Russia. Menshikov responded that Velikhov is the primary source of advice for nuclear issues, but that there is considerable "transition" among science advisors at present. Even if Yeltsin had not acted in December, Yablokov was resigning because he could not get access to the president. Iakimets said that Yuriy Baturin, who holds doctorates in both physics and law, is currently Yeltsin's security advisor. Baturin was the key to the positive outcome of the Mirzayanov case. At a crucial point in the process, a meeting was arranged between Ugolov (sp.???) and Baturin.

Lederberg then turned the conversation to BW issues, saying that he was struck by how little attention the risk of infectious diseases receives in the United States relative to that given to chemical pollution. This is the reverse of the situation 40 years ago. At present there is a slow rediscovery of the old truth that controlling infections is a major problem.

Lederberg noted the ecological implications of continuing research on BW. Knowledge is growing in the West about how serious and extensive the coverup of Soviet/Russian activities was, and there is still a serious lack of candor. He said he had hoped that the new Duma would take up the issue. There have been several authoritative defectors to the U.S. and to Great Britain, so considerable knowledge could be available to the Russian public if people wanted to acquire it.

Menshikov said that, relative to nuclear or chemical weapons, there was very little interest in the Duma or among the Russian public in BW issues. There is a Duma committee, headed by Prof. Bella Denisenka, who was a deputy minister of health, and Menshikov said he would talk to her about organizing hearings. He said he would also talk with Yablokov about adding BW to the work of the Ecology Committee. In response to a question from Lederberg, he said that Duma witnesses are not under oath, so there is no potential penalty for perjury.

Lederberg suggested that ensuring that military research programs on infectious diseases are under close legislative oversight is a good way to provide confidence to the outside world that past transgressions are not continuing. Internal inspection is always more effective than external monitoring, he noted.

Iakimets commented that, because of the changes, it was very hard to keep track of military activities. Thus, for CW destruction, they had proposed a commission of military experts, outside scientific experts, and representatives of domestic and international NGOs. So far, this was just a proposal, but support for the idea from the U.S. might help get it created. He also mentioned that he believed there should be access for citizens to the decision making process for how Nunn-Lugar funds should be spent. At present there is very little access for the public to information. He added that he did not believe that the funds should go for the salaries of those who had worked on chemical and nuclear weapons

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in the past.

Meselson responded that the U.S. had now established commissions in local areas to deal with CW destructions plans. The commissions include representatives from the Army and from citizens groups, and they are given ready access to information. The evidence to date is that the experience transforms both the Army and the citizens. Iakimets commented that, for Russia, he believed that an international watchdog as part of such a group would be very helpful.

In response to a question, Menshikov said he believed that Kuntsevich had been dismissed because of strong opposition within the Ministry of Defense (MOD). He commented that he was just returned from a trip to the United States and was not sure he had the full story. He believed there were two rival programs for CW destruction, the Ministry's and Kuntsevich's and Grachev won Chernomyrdin's support for the MOD. The MOD wanted sole control because of the huge amounts of money that eventually will be spent on CW destruction. The main obstacle to CWC ratification may now prove to be that the Ministry of Defense would be the sole manager of the destruction process. Kuntsevich was at least to some extent independent. Menshikov said that he suspects the President's Committee may be dismissed altogether in the future.

**APRIL 20** -- Lunch with Vil Mirzayanov; additional guest, Graham Pearson, Director General, Chemical and Biological Defence Establishment, U.K. Ministry of Defence

Mirzayanov said that he would support the ratification the Chemical Weapons Convention (CWC), but that he believed there should be a joint U.S.-Russian declaration regarding new types of chemical weapons. He said he had discussed this idea with the chair of the Duma's Committee on Military Security, and that he had been speaking out -- including against CWC ratification -- in part to raise public consciousness about the dangers of chemical weapons.

Lederberg commented that he believed the CWC would not have been ratified in the United States if Mirzayanov had remained in jail, and said that there was a chance Mirzayanov might be invited to testify before the U.S. Congress. If so, any statement he made would be influential.

Mirzayanov responded that he was frustrated because nothing was being done about the concerns that he had raised in his initial article, which began all the troubles he had suffered. The new agents he revealed are not listed in the schedules attached to the CWC and he believed that should be corrected. That was why he believed a joint declaration was necessary to address these problems explicitly.

Meselson stated, and Pearson agreed, that the schedules were not intended to be definitive lists of all possible agents, but rather to serve as starting places and clues for inspection. The failure to include the agents about which he was concerned on the schedules

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did not mean that they were exempt from the broader prohibitions contained in the body of the treaty.

Steinbruner commented that there was a distinction between a statement of personal views and a joint statement by the two governments to resolve the concerns. Statements of the latter sort could help if done well, but could also cause harm if done badly. Before embarking on public advocacy, it would be important to circulate a draft statement for comment from a number of sources. Mirzayanov commented that he was preparing an article for the Wall Street Journal, at which point several people cautioned him that the Journal had its own agenda vis-a-vis the CWC and that he should be careful that his views were not used for purposes with which he might not be in agreement.

Mirzayanov replied that he had testified before the Duma on March 24th and demanded corrections in the CWC. He had said at that time that he would not support ratification without changes. When asked about Zhirinovsky's position on the CWC, Mirzayanov responded that all the generals supported the CWC and that Zhirinovsky would not want to be in the position of opposing the generals and being on the same side as Mirzayanov.

Lederberg commented that there was a real and substantial danger of CW proliferation and that the CWC was needed as a foundation against that threat. To fail to ratify the CWC would send the wrong signal, appearing to legitimate or even endorse chemical weapons.

[On a personal note, Mirzayanov quietly indicated before parting that his and his family's situation is desperate as he cannot get a job in Moscow and needs help.]

**APRIL 20 -- Seminar for Russian scientists about BW and potential cooperative research (see Attachment #2)**

Lederberg began the seminar with opening remarks that stressed themes similar to those in his introductory remarks at the Russian Academy of Sciences meeting:

- o Although the end of the Cold War has eliminated the bilateral BW concerns between Russia and the United States, the risk of the use of biological weapons by third parties, whether nations or terrorists, is greater today and increasing.
- o Both Russia and the United States are vulnerable to these third party threats and therefore have strong incentives to cooperate. Forging strong cooperation will require finding ways to transcend lingering concerns from the past and one good means to do that is through cooperation among Russian and American scientists on joint research to address the third party threats and to advance global public health.

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- o There are signs that the United States government is considering support for the conversion of personnel and facilities that were involved in BW-related research to work on public health research. The CISAC Working Group would like to gather the thoughts and ideas of Russian scientists about possible joint projects.

Lederberg then invited questions and comments from the seminar participants.

Lvov asked if the Working Group really understood the current state of Russian science and what this meant for the ability to collaborate. He said that Russian science was on the verge of collapse, and that both its intellectual and physical resources would soon be lost. If that happens, it would take decades to recover its former strength.

Lvov added that he had been hearing about the possibilities of U.S. assistance for several years now, and in the past had been willing and eager to work on proposals. But little or nothing had come of all the promises and he had learned the hard way about the "long road between talking and doing."

Lederberg responded that he understood and sympathized with Lvov's skepticism. He added that he thought the efforts of private U.S. firms to find Russian partners for joint ventures had been undertaken in good faith. One reason for the lack of major U.S. government initiatives was that the private firms were expected to a source of major investment. But that picture had changed radically within the past year. In the current financial climate for pharmaceutical companies in the U.S., in part because of the uncertainty over the outcome of health care reform, Lederberg said he thought it was very unlikely that U.S. companies would be the source of assistance to Russian science and public health. This meant that the U.S. government needed to reassess its role in aiding the conversion of this vital sector, and that he thought some of this was beginning to happen.

Meselson said that he could imagine three criteria for U.S. support for conversion activities:

1. The projects must be useful for promoting the health of the Russian people;
2. It would be a benefit, but not a requirement, that it also help health in the United States; and
3. The projects should involve scientists or institutes with former ties to the Ministry of Defense.

Lvov responded that very few of the scientists present had any past experience with the MOD and wondered if they could sign up now so they would be eligible for this new aid.

Lederberg and Shelokov stressed the potential for collaborative work between Russian and American scientists to yield substantial benefits for public health in both countries. The Russians would bring real strengths and experience to such collaboration. Their experience with hantavirus and other hemorrhagic fevers is a prime example.

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Chanock said that he believed it should be possible to do more, to develop the capabilities to respond rapidly to both natural outbreaks and the use of biological weapons. He repeated his ideas for the use of antibodies to provide passive protection and suggested that such approaches might be tested in Russia, in the same way that the Soviet Union had conducted the field trials for the live polio vaccine when it was being developed.

Butenko said that he hoped the seminar would move toward more concrete ideas, since so far he had heard only general things. He said he thought such concrete ideas would be relatively easy to develop.

In response to the suggestion that each participant describe his or her current work or ideas for future work, Niconov said that he was working on the protection of wounds from infection. He said he thought expert-to-expert exchanges were the most promising. He also expressed frustration at his failure, after over two years of effort, to find Western partners or support for research and production. He said he believed some Russian products would be comparable to the quality of American goods, and could be made more cheaply.

Popov said he felt that the political leader should solve the problems of monitoring and surveillance for biological weapons control. He said that, personally, he was afraid there would always be people who would do anything for money, so that BW would remain a serious threat.

Lederberg responded that scientists have a responsibility to inform political leaders of risks such as biological weapons, although the final decision will always be political. But scientific expertise was needed to provide the technical basis for making policy. Lederberg added that, in the case of nuclear weapons, both sides recognized the need for secrecy to protect vital information. Yet even in the worst days there had been cooperation. The biological sphere is different, he said, because there complete disarmament is the internationally agreed standard. The nations of the world have agreed to ban biological weapons and offensive BW research and development. Internal monitoring by scientists is simply part of the commitment that nations made to undertake national legislation to support the BW Convention.

Sandakhchiev said that these meetings in and of themselves were not a way to get or guarantee money for joint work, nor a way to prevent BW proliferation. These meetings could contribute to common understandings of fundamental philosophical questions, and of what means were necessary and available to build confidence. He said he was not sure the leaders of Russian science were making use of the opportunities that do exist to find support for their people and laboratories. He cited the model of Soros Foundation grants that help scientists learn how to get access and how to develop proposals as very helpful. He concluded by saying that cooperation on BW issues was not easy as many roadblocks remain in Russia.

Marennikova commented that her laboratory was one that fit perfectly within the criteria that Meselson had proposed. Her director (Sandakhchiev) had proposed cooperative research on smallpox, with which her laboratory has past experience. She added that she had been told that, during a special forum on whether to destroy the remaining collections of



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smallpox virus held in the U.S. and Russia at the International Virology Congress in Glasgow in 1993, Jeffrey Almond from Great Britain had said six countries were illegally preserving collections.<sup>1</sup>

In response to a question from Lederberg, Marennikova, who had been deeply involved in the international campaign to eradicate smallpox, said that the original agreement on destruction had applied only to the two sites, one in the U.S. and one in Russia, where all the remaining collections were to be held pending destruction. There are no penalties for other countries found to have smallpox virus collections.

Butenko suggested that WHO could be the site of a new, rapid response capability, so that in emergencies a team would be available that could assess the source of the outbreak, its seriousness, and the validity of any charges about its origins. Lederberg endorsed the idea, and Pearson added that the UN Secretary General has some capability and authority to undertake such efforts. He noted that obtaining access for the team can be difficult, especially in suspicious cases.

Lederberg commented that some believe the nature of terrorist violence has changed over the last 15 years. In the past many incidents were bids for international attention, and entailed only limited casualties. Today, however, there appears to be more wilful violence that seeks to inflict as much damage as possible. This change was one reason he was so worried about BW.

Prozorovskii commented that his views differed from Lvov's, perhaps because for the past two years he had been totally involved in administration of his institute, whereas Lvov had managed to spend more time on research. He agreed that Russian science was on the brink of collapse -- and feared that the collapse had already occurred. He remembered the first discussions of the CISAC Working Group with its then Soviet counterparts, which had been very fruitful. Those discussions had produced several important proposals that were still relevant. But the only one that has come to fruition is a new monthly journal in Russia comparable to the weekly MMWR in the United States. He supported the idea for mutual emergency response, and agreed that collaboration was the best preventive measure.

He closed by saying that, in the past, the preoccupation of gatherings such as this had been, "Where will the ideas come from?" Now the primary concern is "Where will the money come from?"

Lederberg replied that he agreed that to date accomplishments had been modest, in part because the goals had been so ambitious. In the wake of the massive political changes of the past few years, more has become possible. Channels of contact and access exist now that were unavailable in the past and the current challenge is to take advantage of them.

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<sup>1</sup> Chanock contacted Almond to follow up on this statement while the CISAC Working Group was in London. Almond said categorically that he had not said countries were hiding smallpox virus collections. Rather, he had been told by the British Foreign Ministry that it was believed at least six countries were trying to develop BW. Almond, who supports destruction of the collections, had said he thought preserving them would muddy the picture if these six or others were found to be working on smallpox at some future date.

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**APRIL 20** -- Conversation with Graham Pearson, Director General, Chemical and Biological Defence Establishment, U.K. Ministry of Defence

In response to a question about ideas for strengthening the Biological Weapons Convention, Person said serious thought was being given to mandatory declarations for:

- o high containment laboratories;
- o laboratories working on certain agents; and
- o national biological weapons defense research facilities.

Export control lists could provide the basis for the standards of what would be declared. He suggested that nations would declare that a facility was working on one of the agents on the schedules, and also what sort of work the facility was doing. It is already possible to declare past history of offensive and defensive programs under the BWC. Pearson agreed that, although thresholds for amounts that would be permitted or require declarations would be useful in principle, in practice they would be very hard to develop and implement.

Monath suggested that one could productively focus on aerosol chambers for Class 4 agents as a suspicious indicator, since "nose-only" testing is sufficient for defensive research. Others disagreed, however, that this would be an effective standard.

**APRIL 21** -- Meeting with Anatoliy Monisov, Deputy Head Doctor for the State Sanitary Services, State Committee for Sanitary and Epidemiological Surveillance; Anatoliy Vorobyov, Head of Chair for Microbiology, Virusology, and Immunology, Sechenov Academy of Medicine; Valeriy Popov, Director, Russian Association "Epibiomed;" and Igor Nikonov, General Director, Russian Association, "Epibiomed." (CISAC Working Group members present: Lederberg, Chanock, Shelokov, and Steinbruner)

The first part of the meeting concentrated on epidemiological surveillance. Monisov said that the Russian program was modeled on that of the U.S. Centers for Disease Control, with whom they had a formal program of cooperation. Lyle Conrad at CDC is the principle point of contact. They also have contacts with Alan Kendall, formerly at WHO, and Denny Broun at the World Bank.

There are 2,000 units federation-wide that provide obligatory reporting for 30 diseases. These include cholera, plague, and smallpox, the last case of which he said had occurred in 1962. At the lower levels, reporting is daily, but the cumulative statistics are available about every six weeks. Monisov claimed that they would receive immediate notification of any unusual events or circumstances, and that they could move in without waiting for permission from the local authorities. An "outbreak" is considered more than 50 cases, or 10 cases at the oblast level. Laboratory diagnosis capabilities are poor at the

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county level, Monisov said, so that, depending on the suspected problem, local authorities may call in experts. If there are two or more unexplained cases, they will respond, pulling together a team of appropriate experts. Monisov said that, despite the many problems, the structure and organization of surveillance was in good shape.

The rest of the meeting was devoted to vaccine production and related issues. Monisov said that the Russians had developed 26 vaccines to cover all the major diseases they wanted to target. He acknowledged there were concerns about whether enough material would be available for mass vaccinations against certain diseases. For example, the goal is to vaccinate 95% of children and 80% of adults against diphtheria by 1995 and they did not have sufficient supplies to meet that goal. For DPT and polio vaccines Monisov said the Russians have good production facilities and are comfortable that the vaccines are of high quality. The vaccines do not meet U.S. "Good Manufacturing Practice" standards, but they do meet Russian requirements and they are satisfied with them.

Monisov said that the primary problem the Russians face is that there is only a single source for a number of crucial vaccines, so that there is no back-up capability if problems arise. This is true of measles and tuberculosis, for example. Currently, they are producing measles vaccine with stabilizers, but not always a cold chain. This is an area where U.S. assistance, particularly transfers of the relevant technology, would be welcome.

At present, their key problems are vaccines for rubella and Hepatitis B. Here they face both production and licensing problems. Monisov said he believed that a Hepatitis B facility could be set up for some tens of millions of dollars and claimed that the Russian vaccine is superior to others. He did not provide a clear picture about the situation for the former Soviet Union, as opposed to the Russian Federation.

On the subject of defense conversion, Monisov said that military facilities are not suitable for conversion to vaccine production, and that the major military facilities, including Sverdlovsk, have been shut down. He did not address the question of the reactivation potential of these facilities. He also acknowledged that there is still much to be learned about the military's activities.

Monisov supported the idea of converting the "Vector" laboratory in Novosibirsk to production of diagnostics and re-agents, rather than attempts at mass production. He added that he would be attending a meeting later that day to set up a high-level program for immunoprophylaxis.

He said there had been various meetings with representatives from CDC and the Agency for International Development, but that "not much action" had resulted." Contacts with the Food and Drug Administration, particularly Mary Prendergast, had resulted in an accord that opened the Russian market for American pharmaceuticals.

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**APRIL 21** -- Lunch at the American Embassy with William Menold, arms control specialist

Most of the lunch was devoted to briefing Menold about the various meetings the CISAC Working Group had held. Among the suggestions and comments resulting from the briefings were:

1. Steinbruner suggested that it would be important to find individuals or groups who could engage Vil Mirzayanov in broader discussions of the Chemical Weapons Convention, in hopes of muting his current inclination to oppose ratification. He is at risk of having his understandably strong views exploited.

2. Menold said that it could be useful to have some positive incentives to offer the Russians to encourage greater openness about their past and current BW activities. Right now the climate surrounding the issue is largely negative.

**APRIL 21-22<sup>2</sup>** -- Meeting with the Scientific Aspects of International Security group, Royal Society, and its subcommittee on Biological Weapons

**Members and Staff of the Royal Society Groups:** Sir Ronald Mason (chairman, SAIS); Harry Smith (chairman, BW sub-group); Professor Peter Biggs, visiting Professor of Veterinary Microbiology, Royal Veterinary College, University of London; Sir Arnold Burgen, President of the Academia Europea; Michael Crumpton, Director of Research, Imperial Cancer Research Fund; Sir John Hill, Chairman of Rea Brothers Group; Sir Alec Jeffreys, Wolfson Research Professor of the Royal Society, University of Leicester; Anne McLaren, Foreign Secretary of the Royal Society, Principal research associate, Wellcome CRC institute, Cambridge; Sir Ronald Oxburgh, Rector of the Imperial College of Science, Technology and Medicine in the University of London; Rendel Pease, formerly Programme Director of fusion, United Kingdom Atomic Energy Authority; Sir Rudolf Peierls, Emeritus Professor of theoretical physics, University of Oxford; Sir Martin Rees, Royal Society Research Professor, Institute of Astronomy, University of Cambridge; Stephen Robinson, formerly Director, Royal Signals and Radar Establishment, Malvern; Terry Garrett, Mary Barrington-Ward, and Ling Thompson, staff members.

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<sup>2</sup> The first afternoon was devoted to a discussion of the CISAC plutonium study, and was attended by CISAC members Wolfgang Panofsky and Paul Doty. The BW Working Group arrived in London on the evening of the 21st and took part in the meetings on the 22nd.

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The items on the agenda for the meeting were:

1. Disposition of Excess Weapons Plutonium
2. Issues of Technology Transfer, Nonproliferation and Counterproliferation, and Demilitarization
3. Biological Weapons Issues

Sir Ronald Mason, the chair of the SAIS group, began the meeting by summarizing some of the group's contributions. At present its primary activity is the preparation of the report on biological weapons issues that was commissioned by the British government. Sir Harry Smith is the chair of the BW subcommittee. SAIS has also given advice to the government on the Chemical Weapons Convention, and for the 1995 Nonproliferation Treaty review conference. Mason commented that there have been modifications in the British position on nuclear weapons. The number of warheads on their Trident submarines has been decreased, and Britain is participating constructively in the negotiations for a Comprehensive Test Ban.

### **Disposition of Excess Weapons Plutonium**

Since the members of the Royal Society group had all read the executive summary of the recent CISAC report, Panofsky concentrated his remarks on those items in the report that were the subject of controversy, in particular with regard to foreign civilian nuclear energy programs. Panofsky said that most of the Russians they met continue to assert that plutonium must have economic value because of the costs and sacrifices they endured to produce it. The Russian Ministry of Atomic Energy wants to store the excess plutonium for eventual use in their breeder program, even though it is clear that there will not be sufficient funds of their own to undertake it, and Western assistance is very unlikely. Some Russians are coming around to the idea of transforming the plutonium into MOX for use in current generation light water reactors, but vitrification is unacceptable because it would "throw away" the plutonium. In the United States, the Department of Energy has created an intra-agency process to address the recommendations of the CISAC report, and there is also a separate interagency working group for fissile materials issues.

The commentator for the Royal Society was Sir John Hill, former chairman of British Nuclear Fuels, Ltd. and currently a member of a commission reviewing nuclear weapons safety. Hill emphasized that he could not speak for the British government. Hill opened the discussion by saying that they had very little disagreement with the CISAC report. In particular, they were in full agreement with the recommendations on increased transparency via declarations, mutual inspection of dismantlement, security measures, and intermediate

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storage. Hill agreed that the best alternative storage form for the plutonium was as "pits."

Since there was such general acceptance, he turned his attention to disposition issues. Hill agreed that reactor-grade plutonium could be made into viable nuclear weapons. He suggested that dealing with civilian plutonium may be a greater challenge than dealing with weapons plutonium. Within five years there will be as much separated civilian plutonium as weapons plutonium, and the civilian stocks will continue to grow.

Hill agreed that reprocessing plutonium from spent fuel at Sellafield was economically unjustifiable. The choice of MOX versus uranium fuel was a matter for the utilities, he said. Hill stated that the only reason the THORP reprocessing facility had opened was because of financial obligations and government-to-government agreements. Two-thirds of the facility had been paid for by Japan and Germany; Japan provided 50% of the construction costs, for example. Those funds would have had to be repaid if THORP had not opened. With THORP in operation, repayment will be in the form of reprocessed plutonium rather than money.

Both Japan and Germany require a closed fuel cycle as a condition for operating licenses for their nuclear power plants, so if THORP had not opened, many reactors might have had to shut down. Hill said he believed that, in the future, the German and Japanese utilities will accept plutonium in the form of MOX, which would be burned in once-through cycles. He said he believed this was the only valid route to closing the fuel cycle, and there was no justification for breeder reactors. Apart from "saving face" the Japanese were obligated to proceed in this manner because they lack adequate storage facilities, either wet or dry, for their spent fuel. Hill did not respond to the question of why the Japanese did not simply build more storage facilities.

Hill agreed that strong, secure storage for separated civilian plutonium is essential. He said that such storage in the U.K. (there are 36 metric tonnes at Sellafield) is extremely secure, and invited CISAC to inspect the vaults. He said that a MOX plant would be built at Sellafield as there was no hope of shipping plutonium in the future. Ten metric tonnes of plutonium will be processed into MOX each year.

Hill suggested that an independent study to reopen the issue of a thorium fuel cycle was in order. He believed that the thorium cycle could be controlled such that the Uranium-233 contained in the cycle would always be mixed with sufficient quantities of U-234 and U-236 to avoid the presence of weapons-usable materials. He also said this would reduce the ultimate waste that would have to be stored by 10-100 times over a long period.

In response to a question from Panofsky about the British reaction if the U.S. chose the vitrification option, Hill said he thought it would be perceived as another signal of the strong U.S. opposition to reprocessing. In response to a question from Doty about the British reaction to retrievable storage in very deep underground repositories, Hill said he thought the British would favor such an option, but he agreed that the licensing obstacles would be formidable.

In response to a question from Pease about whether the use of MOX in current Russian reactors would be more dangerous, Hill said that it would be for those reactors that

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operate at 700 degrees centigrade. In response to a question about whether the U.S. (West) should support a deal in which Russian-made MOX would be sold abroad, Panofsky said that the main goal was to get Russian weapons plutonium moved to the "spent fuel standard" as fast as possible. The Russians should either burn MOX in their VVER 1000 reactors or export the fuel. He said that the recent CISAC visit to Moscow had found that the Kurchatov Institute and the GAN (Gosatomnadzor, the equivalent of the U.S. Nuclear Regulatory Commission) were becoming sympathetic to the MOX alternative.

### **Issues of Technology Transfer, Nonproliferation and Counterproliferation, and Demilitarization**

Mason began his presentation by noting that the threat of the proliferation of weapons of mass destruction has been with us for a long time, but that in the last two years, it has risen to the top of the security agenda. Two different themes are at the center of the policy debate:

1. Strategies to prevent proliferation through dissuasion, diplomacy, and export controls; and
2. Strategies to manage proliferation if it occurs, which involved deterring, devaluing, and perhaps destroying the new capabilities.

Mason said he believed the man in the street sees nuclear weapons and ballistic missiles as the key threat. He noted that the Nonproliferation Treaty and its accompanying regime do exist, and that in the past control has been relatively easy because it could concentrate on controlling access to fissile materials, the essential ingredient of nuclear weapons. The recent progress toward a comprehensive test ban treaty has given political momentum to the extension of the NPT in 1995. Looking beyond NPT renewal, Mason saw the need to develop more stringent safeguards, to provide positive and negative security guarantees, and to address the rights of nonnuclear states.

Mason said that the nature of the bargain underlying the Missile Technology Control Regime inevitably raised complaints about unfairness in access to technology. There were also basic disagreements about whether missiles were destabilizing, for example, from China in response to Western objections to its transfers. Mason said there was a fundamental question about what action MTCR adherents would be prepared to take in the event of a violation -- what peaceful steps? What if the peaceful steps do not work?

Another important issue is how far Europe should go toward developing theater missile defenses. Great Britain, France, and Italy are all considering programs, and Mason said he believed any future program must be collaborative and must be cost-effective. It should also include options for pre-emptive actions, such as the Israelis took against Iraq in

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1981. He stressed the need for strong intelligence, with more attention to motives and intentions than they had received in the past.

Mason said the Chemical Weapons Convention is a remarkable achievement, but it raises very difficult implementation questions. One of the key ones is the balance between national export controls and providing nondiscriminatory access to technology and materials. He also said that some countries want to link ratification of the CWC to addressing Israel's nuclear capability.

Finally, Mason said that technology transfer issues were becoming more difficult. If the real definition of technology transfer is the provision of "implementable knowledge" then there are few ways to contain this process. Biotechnology, for example, is the essence of dual-use technology. These issues raise profound problems of intellectual freedom, human rights, and how far to go to restrict these in the name of national security.

Steinbruner agreed that the process of technology diffusion -- both knowledge and the ability to apply it -- poses difficult problems. One can regulate the process by consensus, but it is not possible to deny access except in a few cases, such as fissile materials. With this diffusion and the changing military balances after the Cold War, it is becoming more possible for states to acquire offsetting capabilities to match those of the great powers. Weapons of mass destruction are an obvious example, but there are others as well.

These changed circumstances require shifting focus to regimes of disclosure rather than of denial. Systematically enforced disclosure, for example through trade arrangements that make disclosure a routine part of the transaction, are the best hope. Better accounting standards and methods than those used in the past will have to be developed, since reporting will be a major part of the regime. This demands an inclusive coalition, bringing Russia and China into the regime, and reaching out to as many others as possible. This coalition does not yet exist and work needs to begin on it soon.

On the issue of nuclear weapons, there are discussions under way regarding fundamental changes in operations. Up to now, the U.S. has pursued very active deterrence, maintaining high rates of alert and preparations for rapid reaction to attack. Operational safety -- the avoidance of accidents or unauthorized actions -- has been taken very seriously but has been subordinated to the preservation of active deterrence. Under current circumstances this priority should be shifted, making safety the primary objective and the preservation of deterrence a subordinate constraint. This is a particularly important shift to make since the former Soviet Union cannot be expected to conduct safe deterrent operations indefinitely. The current military budget is about 1/4 of basic financing requirements. Many things are suffering from the scarcity of resources. So far, the Russians appear to be maintaining their nuclear weapons relatively well. But they must move to a safer posture, such as physically separating the warheads from their launchers and storing them separately. Achieving this on both sides will require a much higher level of mutual confidence than currently exists, and building that confidence will require much more mutual knowledge and disclosure about inventories and locations.

Oxburgh commented that one must also take account of criminal activities, beyond the



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range of state actors, such as the international narcotics networks. If one deals with proliferation only at the level of inter-state treaties, one will not address the problem fully. Moreover, with "rogue" states there may be links between nations and criminals.

Doty asked what is happening at present. COCOM is gone, and has not yet been replaced. The Clinton Administration has announced a nonproliferation initiative, and the United States has a list of items it wants to control, but what is happening?

Steinbruner responded that drugs are a quintessential international problem. At present, the problems are being addressed in fragmented ways, both internally and internationally, but the problems will push nations toward greater cooperation and collaboration. He noted that what the COCOM countries have ended is the attempt to restrict dual-use technology; restrictions are still in place for weapons and a few other items. He expressed concern that the policy changes are not happening fast enough, that governments "just don't get the point."

Mason said that there were a number of regimes, such as the UN register, the Australia Group, and the London Suppliers Group, but that as yet there were no standard accounting practices.

Robertson commented that knowledge is so widely diffused that openness is the only answer. It is still possible to control whole major weapons systems (an airplane, a tank), but that is only one piece of the problem.

Panofsky commented that he disliked the term "weapons of mass destruction" since it lumped together some quite different proliferation problems. He expressed concern that this mingling would encourage thinking about the use of nuclear weapons to respond to chemical or biological weapons proliferation. He stressed that the NPT bargain involved nonnuclear states foregoing nuclear weapons in exchange for access to peaceful nuclear technology and the nuclear powers' commitment to seek nuclear disarmament in good faith. He noted that Iraq's Osirak reactor was not in violation of the NPT, and was not engaged in reprocessing, so Israel's attack broke the NPT bargain. It was not a shining example of counterproliferation, he said.

As for the theater missile defense debate, Panofsky noted that even theater defenses raise dangers of escalatory processes. The best example would be the Russian-Chinese case, where competitive deployments could raise tensions. This is particularly true since the Chinese have largely been outside the process, and the motives behind their programs are uncertain.

Mason responded that at present the European discussions are focused on very limited inventories. He added that he believed that CW and BW proliferation posed much greater dangers for the future than nuclear weapons did.

Panofsky commented that BW is particularly attractive to terrorists, but that the BW Convention deals only with state-level issues.

Pease commented that for the next two years NPT extension is the key problem. The U.K. has so far been reluctant to sign a CTB and to reduce its nuclear arsenal. He asked about the goals of the U.S. government for the 1995 conference. Did it hope to gain

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stronger verification provisions, greater resources for the IAEA, or simply an indefinite extension?

Panofsky responded that there is no official U.S. position yet. Steinbruner added that the goal is clearly indefinite extension. The government does not believe that is attainable, however, so it is seeking as long an extension as possible and other improvements such as strengthening the IAEA. He said he believed the U.S. was now firmly committed to a CTB.

Steinbruner commented that the nuclear review now under way in the U.S. was revealing various proposals to expand the role of nuclear weapons beyond the fundamental one of deterring the use of nuclear weapons by others. He thought such ideas were very dangerous for the NPT. He said he believed the political dangers were recognized at the White House level and that at present the response was to say nothing about the role of nuclear weapons while the bureaucratic process played itself out. But silence is not productive either. In addition, the new Russian military doctrine, which abandons no-first-use and adopts the NATO position, is bad as well.

Panofsky said that he found the discussions of nuclear weapons as "weapons of last resort" disturbing, since it seemed an open-ended invitation to proliferation. Without much difficulty, any nation could construct a case for needing a "weapon of last resort," he said. He said he found all the major nuclear powers very unclear in their statements about the roles of their nuclear weapons, and that the problem needed sustained, hard thinking.

Pease said he thought it was very important to make some concrete moves toward nuclear disarmament, some clear demonstration of commitment to NPT's Article VI.

Oxburgh commented that this was a moment of great opportunity for the United States to promote a strictly limited role for nuclear weapons, since the country cannot be challenged on conventional grounds. Panofsky and Steinbruner both responded that, although very desirable, they thought such action by the U.S. unlikely.

Mason commented that, in a speech to King's College last fall, U.K. Defense Minister Malcolm Rifkind had talked about the role of nuclear weapons as an insurance policy against the uncertain future of world politics. He also spoke of the popular awareness of the proliferation danger, which led to pressures against reductions: "How can Britain give up nuclear weapons when Libya is trying so hard to get them?" Mason added that right now nuclear weapons issues are not important in Britain and debate is muted. He thought that the responses were being driven by politics and emotions rather than any firm doctrine -- "We'll be ready to talk when you [the U.S. and Russia] get down to 400" -- and a strong sense that American and Russian actions had little to do with Britain. Oxburgh added that he thought there were strong elements of realpolitik underlying current British thinking.

In response to a question from Doty, Mason said that concern about possible German interest in nuclear capabilities was not part of the British rationale for its own force, but there is discussion between the U.K. and France of the circumstances under which Germany might go nuclear.

Steinbruner said that he thought the distinctions among prevention, management, and reaction were very important, and that he thought management issues were getting lost in the

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current U.S. debate. He said there is at least some consideration of using nuclear weapons for counterproliferation in the current review of U.S. nuclear process, but that he believes it will not survive the bureaucratic review and consensus-building process. He said it seems clear that the U.S. does not appreciate the links between prevention and reaction: If one really wants to consider coercive reactions, then one needs to have made a very strong record on prevention. He believes that norm is not strongly established enough so that, for example, it would not sustain military action against North Korea.

Mason commented that there was an anecdotal view in Britain that Israel used its nuclear weapons to deter Iraq from using chemical weapons in the Gulf War. Steinbruner replied that there may have been some existential deterrence effects. Even if one declares a limited, core role for nuclear weapons, one may still get other benefits, such as instilling caution in opponents.

Oxburgh said that British nuclear thinking was not very coherent at the moment and that no one should pretend that it is. Possession of nuclear weapons provides a sort of nuclear virility symbol. Discussions also come down to certain basic political arguments: "If it requires the same establishment to maintain 6 nuclear weapons as several hundred, why not have the larger force?"

Steinbruner responded that these practical questions were very much part of the U.S. nuclear review as well. His personal view is that we do not appreciate how important it is to bring Russia into more sustainable relations. If we do, we want Russia's command to remain coherent, and this implies an immense level of involvement on the part of the West. In time, this would lead to a significant stand-down of forces. This is also a necessary way station on the path to zero nuclear weapons.

Oxburgh said he was very interested in the implications of the new capabilities for overhead surveillance. There is now a practical capability to inspect from space, if what one is trying to detect is change. The U.S. has this capability, Russia has much of it, and so has France. This approach is cost-effective; there is no reason why archiving of satellite photos could not be done routinely. Such practices would provide confidence and protection against future false alarms.

Steinbruner agreed that this was a very powerful potential tool if coupled with collaboration. To make this capability reach its full potential -- and the consciousness is just emerging of this possibility -- systematic collaboration would be needed.

Pease asked about U.S. policy on the kinds of verification that it would like to see emerge from the 1995 NPT review conference. Steinbruner replied that no clear policy had been developed, and the U.S. was not yet fully prepared for 1995. He said there would be serious concern about not overloading the NPT with this level of intrusion; the U.S. would have to be willing to subject itself to this, and the consensus was not there. Panofsky commented that the NPT agenda was already loaded with less relevant things, such as CTB, which is politically important but not very technically significant.

Oxburgh raised the issue of proposals in the U.K. to prevent students from certain "undesirable" countries from studying proliferation-relevant subjects. This was the subject of

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ongoing discussions between the government and the universities, and little progress was being made. He offered the opinion that, although weapons had not changed much over the last 15 years, their delivery and precision had grown greatly. The basic knowledge for the potency of weapons of mass destruction was based on 50-year-old technology that it was unrealistic to try to restrict.

Panofsky agreed strongly, saying that general, diffuse controls were futile. Oxburgh added that this might make openness a price, and Steinbruner responded that was exactly right. The idea for the new regimes of disclosure was that access depended on following the rules. If one breaks the rules, then isolation follows. Panofsky added that this idea had not yet penetrated the political process, however.

The discussion then turned to theater missile defenses. Mason said that the ABM Treaty does not seem relevant to the current European concerns. France is concerned with the threats it may face from across the Mediterranean, especially with cruise missile technology on the horizon. The U.K. enters the picture with concerns about missiles with extended ranges. The official U.K. request for proposals to explore theater defenses explicitly says that any proposed approach must be collaborative.

Oxburgh commented that missiles were relatively cheap, but the defenses against them are expensive. Warhead fragmentation is a key problem, and this drives toward intercepting a missile as close to the launch point as possible. Steinbruner commented that there would need to be strong limits on offensive forces to give defenses any chance of success. Oxburgh responded that, in Europe, one can separate detection and tracking from countermissile capabilities, so that the possibility existed to have common surveillance and common early warning, while preserving options for national responses.

Steinbruner added that the real threat would come from cruise missiles, and at least the U.S. was not addressing this problem. Oxburgh said that this represented a different technical problem, and that it could be dealt with.

On the topic of demilitarization, Mason observed that it seemed to be clear Russia would not be able to meet its obligations under the CWC. There was no implication of bad faith, but the current budgetary and political situation just would not permit it. Doty agreed that they would not be able to afford destruction, and that he expected the Russian government to announce at some point that it could not ratify the Convention until it has assurances of assistance to meet its commitments to destroy its stocks.

Meselson said that he had been told in a meeting with the Ministry of Foreign Affairs that Russian ratification could not be expected in 1994. He said Russia might meet the treaty schedule for neutralization and then postpone what to do with the residues. But the greater uncertainties are how to get the treaty through the Duma -- the political barriers are far harder than the technical ones. In response to a question, he said that it would not be possible to change the schedules without changing the treaty and that nobody wants to reopen the Convention. Thus, the window for securing ratification is relatively narrow. He added that he thought American ratification was nearly certain, but Russian was less so.

Meselson said that the U.S. and Russia had undertaken a bilateral commitment to

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destroy their stocks by 2000 and that could be allowed to slip. He added that a good step would be for the permanent secretariat to define the "irreversible destruction" called for in the Convention as including hydrolysis as well as mineralization. There would be less domestic opposition to hydrolysis.

Lederberg commented that there were a daunting number of possibilities for delay, such as the immense problems of getting domestic political consensus on destruction sites and technologies. It might be worth touching the Convention to allow slippage because of domestic political problems. He added that Russia would have an easier time neutralizing its stocks because of the way their weapons are designed. They have already stated that they are in compliance with the disabling requirement in the Convention.

Meselson noted that some Russian chemical weapons contain arsenic, and some Russian officials want to recover this. He was concerned that there had been no pilot-scale demonstrations of hydrolysis or solvolysis for either mustard or VX. The process seems straightforward, but it has never been done, even though mustard has been stockpiled for more than 70 years.

Mason concluded the session by expressing the hope that further discussions of technical issues might continue between the two groups.

### **Biological Weapons Issues**

**The Work of the Two Groups.** Smith began by describing the work of his subcommittee. They had been convened for a particular task. In the aftermath of the Gulf War and in anticipation of the review conference on the Biological Weapons Convention in 1996, the Royal Society decided to undertake a study of the scientific aspects of biological weapons control. The study, which is nearing the end of its review process and is expected to be released this summer, concentrates on issues of verification and technology transfer.

Lederberg said that the Working Group on Biological Weapons Control was an offshoot of the main Committee on International Security and Arms Control. Unlike most National Academy/National Research Council committees, its purpose is not to produce a report. Instead it has functioned as a back channel of communication with Soviet/Russian scientists. There is no effort to develop a bilateral consensus and no joint statements. The stimulus for the creation of the Working Group was the lack of candor and openness from the Soviets about their BW activities. Until President Yeltsin admitted that the Soviets and later the Russians had violated the BWC, there had been only suspicions. It was clear that they were not living up to the BWC obligations for candor, but nothing more serious could be proved.

The discussions with the Russians have been through many changes. There is now more emphasis on confidence-building measures and on exploring ways to strengthen the BWC. There is also a new interest for the Americans in encouraging the U.S. government to provide assistance to support the conversion of facilities and personnel formerly engaged

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in BW-related research. Lederberg said he thought there were some signs of movement in that direction in Washington. The Russians, however, were leery, since they had received many promises, but little in the way of concrete assistance.

Lederberg offered his personal view that he did not see any very reliable way to prevent biological warfare. The technical thresholds are low, programs are easy to hide, and verification is impossible. The World Trade Center bombing is a grim reminder of what could happen. Russia would not be the author of such a use, he said. Lederberg added that he did not know how to stop the threat and believed it should be addressed as part of the broader problem of what to do about infectious diseases generally. He felt that a better job could be done with this problem, but for the next 20-30 years, the offense will have a great advantage.

On the other hand, one must note that BW has not been used much in recent times. The reasons why it has not apparently lie in the realm of psycho-social phenomenon. The main argument today against having a BW program is that it would encourage others. We are mostly worried about a contagion of ideas, which means one should worry about how much publicity to give the issue.

He said that the Working Group had found the Russians very aware of the BW problem, and that they acknowledged they are especially vulnerable to third party threats. Lederberg concluded by saying that, if control and verification are unachievable, then cultivation of the positive is far more important than final destruction of the negative. It is critical to find ways to transcend the past of Soviet/Russian activities and to cooperate.

Steinbruner said that BW was the quintessential case of the need for regimes of transparency. The history of suspicion about the Soviet/Russian program has left us in a poor position to respond to either third party use or a major natural outbreak. Preparations are simply not in place.

Smith said that at present the BWC was only concerned with relations among nations, and there was no international mechanism to address the terrorist threat.

Crumpton said he believed that terrorism was the key threat, and that all that would be required was a credible threat to cause great damage.

Biggs noted that there might be states who would hide behind terrorist activities. Lederberg responded that the BWC does cover the transfer of biological weapons to others, so that state-sponsored terrorism, if it could be proved, would not be shielded. In general, international law is weak on terrorists acts, and provided little ability to pursue, prosecute, or condemn such activities.

Meselson said that he believed the BWC contained an embryo that could be developed to deal with terrorism, since it calls for states-parties to enact legislation to support the BWC. At least the U.K. and Russia, and perhaps the U.S., have enacted laws that ban individual use of biological weapons.

He said he saw the key issues as ones of motivation and consciousness. Do certain actions, whether responsible or irresponsible, encourage others? He said he believed states needed much higher standards of accountability, that BW should not be used to gain

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propaganda advantage lest it come back to haunt us. Governments, groups, and scientists needed to give careful consideration to what they said about BW issues.

Smith and Burgen responded that these considerations had led the Royal Society group to decide against a pamphlet on BW aimed at the general public.

Robinson asked if Meselson was suggesting restricting knowledge. Lederberg responded that the knowledge was too widely disseminated, and it would be ludicrous to try to contain it. But we should not promote more interest in the idea of BW than already prevails.

**The Russian Scene.** Lederberg said that the group's official contact was the Russian Academy of Sciences. Since that meant the exclusion of scientists from the Academy of Medical Sciences, the Working Group had held a seminar in addition to its meetings with the RAS, and invited medical scientists to learn more about its work. All the discussions point up that material survival is the overwhelming preoccupation of the institutes right now, and they have time for little else. The situation is not helped by the on-and-off nature of American assistance.

Nonetheless, four or five promising project ideas emerged from the discussions, where the Russians have strengths and experience and the results could do good. One is the ecology and pathogenesis of anthrax. Although rather removed from immediate BW concerns, the project would involve people with a past history of BW-related research. The paradox is that it would reward the "bad guys," while good scientists continue to suffer.

Lederberg said the Working Group had identified three tiers of Russian involvement in BW. The Russian Academy received substantial funds from the Ministry of Defense to support general biological research. He said he does not believe any institute of the RAS can be directly implicated in weapons work. The second tier is the equivalent of the military design bureaus, with Biopreparat the best known facilities. The head of the Biopreparat facility in Novosibirsk, Academician Lev Sandakhchiev, is now in our Russian counterpart group. He does not admit to any weapons-filling work, but there are several defectors from his lab now in the West who make clear that they at least skated very close. Finally, the direct military work is largely still hidden. Our intelligence and military people say they do not have access and that the Russians are not being forthcoming. The Russians say they have shut down all military work, but such activities are so easily revived that considerable anxiety remains.

In response to a question, Lederberg said that to the best of his knowledge no one but Russians had been involved in BW work in the FSU, and almost all the facilities were within the Russian federation. One exception, an important island testing site in Ukraine, had been dismantled soon after the breakup of the Soviet Union at Ukrainian insistence.

Steinbruner said that scientists like Sandakhchiev say that they support the BWC, that they want to convert to peaceful work, and that they are free to do so. He said there is a great need to find ways to transcend the past.

Lederberg commented that there might have been a lost opportunity during the visit of

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CISAC's Soviet counterparts to the Swiftwater vaccine production facility in 1990. The visit took place just before the Gulf War, when Arafat was threatening the use of germ warfare on Israel. The two groups developed a joint statement condemning such threats, but the Councils of both academies turned the statement down. He said he still believed it would have been an important act.

Monath described his idea to convert facilities such as NPO Vector in Novosibirsk to part of a global effort to monitor and conduct research on dangerous diseases. There is no commercial market for such work, but an immense public health need. This approach would retain the expertise where it is and, without great changes, turn the work to productive purposes.

Lederberg commented that the problem was not of turning swords into plowshares, but of finding ways to engage people in constructive work. There is a great need to identify small projects that could have a catalytic effect. Two years have been lost while the U.S. government and others hoped that the private sector would provide funds and ideas to accomplish conversion, but that is not going to happen. He repeated that such ideas would only reach two of the three tiers of BW research.

Steinbruner said that he believed the military had shut down its facilities and moved away from BW work. Funds are so tight that BW work, which has no direct military potential, is unlikely to survive. He repeated the sentiment of others in the CISAC group that an opportunity exists to catch a crucial tier of the process and engage it constructively.

In response to a question about whether, given the wide dissemination of knowledge, it was truly important to invest in BW conversion, Monath said that he believed there were certain kinds of expertise that one should try not to lose. One example is work on aerosols and on the engineering of aerosol delivery systems.

In response to a question from Crumpton about the potential of working on animal vaccines, Steinbruner replied that the Working Group had not considered this, but it was a good idea that should be included in future.

Biggs asked about conditions in other republics of the FSU, and Shelokov responded that, at least for Ukraine, which he had recently visited, there was not enough DTP vaccine to meet Russian needs, so they held back on their commitments to Ukraine. Oral polio vaccine and measles vaccine were to come from Russia, but Ukraine was short of money to pay for the shipments. He said that there had been more vaccine production capacity in Ukraine and other republics, but in the 1980s the Soviets tried to draw production capabilities back to Russia. The Canadians are supporting a World Bank loan to Ukraine that would permit it to raise its facilities at Kharkov to GMP standards.

Shelokov said Uzbekistan is getting help from South Korea, since there was a sizeable Korean community there as a result of Stalin's forced movements of peoples. The plan there is to start with Hepatitis B, building on existing Korean capabilities. Daewoo and Green Cross are currently competing for the project, with payment to come in cotton, copper, and gold. Uzbekistan hopes to eventually become the primary vaccine producer among the Central Asian republics.



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**Epidemiology of the 1979 Anthrax Outbreak in Sverdlovsk.** Meselson presented the results of the research that he and his colleagues, including Alex Shelokov, had been doing on the epidemiology of the anthrax outbreak in Sverdlovsk in 1979 (see page 16). The results of the research have been accepted for publication in Nature and are due out in the late spring or early summer.

Chanock suggested the possibility of using human monoclonal antibodies as therapeutic or prophylactic protection against either BW or a natural occurrence. The possibility for efficacy of human antibodies is especially important since one expects a terrorist attack to come with little or now warning.

**The Royal Society Study.** Lederberg raised the issue of how to move toward a multilateral approach.

1. What should be done about arms control vis-a-vis third parties, now that the Russo-centric approach of the past is no longer valid?
2. What approaches to verification and control would be most relevant?
3. What about civil defenses, including damage control, and emergency response teams?

Biggs responded that the Royal Society group had not addressed civil defense problems. Smith added that a key concern was what to do about the terrorist threat, which the BWC does not cover. The only way to ward off such threats is with good intelligence. Then various verification measures could be applied once intelligence identifies a threat. Burgen said he agreed that the Russian threat was not central, and that the focus should be on developing countries.

Smith said that the British Ministry of Defense does plan for emergencies with a range of classified programs to identify the nature of an attack and make an appropriate response. He said he felt confident in saying that the British authorities were aware of the BW threat and were addressing it seriously. The Royal Society group focused its attention on the upcoming BWC review conference in 1996.

Jeffreys commented that it could be difficult to distinguish between state-sponsored terrorism, which might be somewhat amenable to standard diplomatic efforts, and independent groups, which probably would not be.

The Royal Society group had looked at verification problems in great detail, Jeffreys said. They agreed with the thrust of the VEREX process that there was no single measure that could be applied to all cases. They had thus divided their work to address on-site, near-site, and remote verification problems.

For on-site verification, this stage requires simple, robust techniques that can be applied at the suspected facility. One would want two independent tests per suspected agent,

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and these tests should be internationally validated at a later date. Just detection is not enough, one needs to identify the agent conclusively. In addition, there are various techniques -- x-rays, neutron activation, or simply swabbing the outside -- that can be used to examine complete and filled munitions.

With near-site verification, immunosorbent materials may be used to try to detect emissions from the facility. Since many agents give off distinctive odors, monitoring those odors using humans, or even better dogs, could provide clues. One could also use spectroscopic interrogation of exhausts.

Finally, with remote verification, which would be applied to undeclared but suspect facilities, one could use visual identification and perhaps thermal mapping.

Overall, a variety of both basic and sophisticated technologies are available. The large-scale, declared facilities would be the first objects of verification, but Jeffreys said he believed some of the techniques could be applied to smaller facilities and those alleged to be engaged in peaceful activities.

Smith said that it would be very important to encourage confidence-building measures, which could be applied to high-containment sites, and to vaccine production. The Royal Society group believed that BWC should have a permanent administrative office, to send out and chase down the various reports. He also supported the need to simplify the current forms to make reporting more likely.

Lederberg asked what would be declared, and whether there might be thresholds of permitted and banned activities. Biggs replied that he did not think thresholds were feasible, and therefore favored annual declarations of the production of listed agents. Smith agreed that it was not sustainable to try to make limits.

Lederberg responded that he believed that if there were going to be declarations, there would have to be thresholds. He suggested that perhaps a volumetric threshold -- one liter per day, for example -- would work to separate bench-level work from industrial processes.

Steinbruner added that thresholds would not catch terrorists and one did not expect them to. Declarations would encourage collaboration among military establishments, however. The fundamental purpose would not be to deny access, but to encourage reporting as part of the broader norm of disclosure.

Meselson suggested that perhaps just an annual declaration of work within a given period, without any thresholds, would be as much as one could hope for. In the end, one will have to rely on the judgment of inspectors. Lederberg commented that that would provide no standard of behavior, and Biggs responded that it was simply not feasible to make a comprehensive list. Steinbruner responded that he believed one would be better off with an admittedly incomplete list of 30 agents that must be disclosed than no list.

In response to Lederberg's question about what would be prohibited, Smith agreed that filling munitions would be banned. Monath and Steinbruner added tactical aerosols and vector containment. Monath suggested that weaponization requires aerosol experimentation and that should play a prominent part in any verification scheme, since nose-only tests are enough for vaccine research. Smith agreed that aerosol work was an important focus for

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verification efforts.

Smith asked about the use of serum samples, or perhaps samples of saliva or sweat, from workers in facilities being inspected. Lederberg agreed that these could be helpful, but noted that they might be both politically sensitive and subject to false positive responses, which would then have to be explained. He suggested that, like polygraph tests, such tests might have a useful deterrent function. He stressed that one wanted to avoid an adversarial process, and intrusive verification could carry a large negative political load.

Steinbruner suggested trying to find a positive way to frame the verification issue, such as providing necessary reassurance. Jeffreys agreed that one wanted to avoid an adversarial process, and suggested that some techniques of on-site inspection could alleviate proprietary concerns, since evidence generally would not need to be taken away for further analysis. Steinbruner agreed, and said that he thought several of the near-site techniques Jeffreys had outlined sounded promising as well.

Biggs raised the question of the compass of the BWC and how to handle toxins. Lederberg responded that he would prefer to see toxins handled as part of the CWC. Smith replied that he was afraid they were stuck with having it in both treaties, but that the definition should be the same in both. Lederberg responded that it could not be done, since one could distinguish biological agents from toxins, but cannot distinguish toxins from other chemicals.

Lederberg suggested that there are some gray areas in the BWC that it might be time to address. For example, the Convention deals only with state-to-state relations and perhaps a way could be found to encompass other activities. He also suggested banning the use of organisms against materials, in addition to the already-prohibited use against plant and animal life.

On the issue of compliance, Lederberg raised the question of whether the BWC should continue to require a unanimous vote of the UN Security Council, at least for an investigation. Meselson responded that a General Assembly resolution had given the Secretary General the authority to investigate chemical and biological incidents. Some quick response capability now existed to deal with allegations.

On the question of technology transfer, Lederberg suggested that perhaps something might be done with end-use certificates for certain kinds of equipment, such as large fermenters. Steinbruner agreed, saying that one wanted this kind of practice to set standards. Lederberg added that one did not want to create a large bureaucracy or onerous reporting requirements. What he had in mind was having all sales contracts contain an end-use certification and clause providing a right to inspection. Manufacturers would have automatic licenses to export the equipment provided the contracts contained these clauses.

Steinbruner commented that the United States government had been unable to reach consensus on issues such as these, which had prevented the reauthorization of the Export Administration Act for three years. He advocated making exports of most equipment legal provided that manufacturers declared what they were doing.

Meselson said he believed one should start small, and favored declaring all P-3 and P-

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4 facilities, as well as where one might be working on any agent from the list. One would not have to say which agent, but the work would have to be acknowledged. Lederberg noted that this would help the BWC, but was not necessarily the approach for national export controls.

Smith closed the discussions by commenting that he had hopes for achieving greater international cooperation. He thought it would be possible to build on the good will created in the VEREX process. He also supported cooperative, retrospective investigations, such as of Sverdlovsk, and noted that there had been an anthrax outbreak in Zimbabwe that some suspected might be BW. Monath suggested that it could be helpful to think through more carefully the detection and investigation of natural outbreaks and how this related to, and might assist, BW verification.

**"CRITERION RATING" AS A MEASURE OF PROBABLE USE OF  
BIOAGENTS AS BIOLOGICAL WEAPONS  
Anatoliy Vorobyov (CISAC Translation)**

Classification of bioagents (bacteria, viruses, fungi, toxins) by the likelihood of their use as biological weapons is important not only for planning and developing defense measures against BW, but is also essential for organizing and implementing controls over activities in this area.

Of the immense universe of microbes inhabiting this planet in coexistence with man and animals, approximately 3,500 are pathogenic or "conditionally pathogenic" for man, i.e., capable of causing disease. To "suspect" this entire "armada" of possible usefulness in creating BW would be not only unscientific and senseless, but also would disorganize the system for inspection and control of illegal activity aimed at BW development.

To be used for BW, bioagents must satisfy certain criteria based on their biologic parameters and interrelation with man and the environment, as well as technical and economic indices.

Attempts at classifying microorganisms as potential BW agents have been made by many researchers, including members of our group -- Dr. Raevsky and Professor Monath.

Each of these attempts has brought a certain degree of common sense and order to the problem. However, we believe that due to its complexity, the problem still requires final resolution.

Therefore, we have tried to approach the problem from other angles used frequently in evaluating various phenomena. We applied the criterion-rating approach to assessing the likelihood of the use of bioagents as potential BW.

But before outlining this approach and the results obtained, I would like to present our view on the classification of bioagents as biological weapons. Our proposed classification is presented in Table 1.

This classification divides all bioagents into three groups. The first includes all natural bioagents capable of causing mass outbreaks of disease among humans. These bioagents must satisfy a number of requirements listed in the table. This group includes only the agents capable of causing mass outbreaks of human disease, as inclusion of individually hazardous agents would result in having to include all pathogenic -- and even "conditionally pathogenic" -- microorganisms, the overwhelming majority of which are of no interest for BW development.

The second group includes natural bioagents that may be used for terrorist purposes ("diversionary purposes"). In addition to the properties possessed by agents in Group 1, these bioagents must also meet a number of additional requirements shown in Table 1.

Finally, the third group includes all bioagents produced artificially by one or another means that possess properties which may enhance or mask their effect and thus widen the scope of their possible use. These properties are listed in Table 1.

Based on this classification of bioagents as BW, and taking into account the requirements they must satisfy, we have attempted to rank specific bioagents in accordance with the likelihood of their actual use.

For this purpose we have defined certain essential criteria that determine the probability of a microorganism being used for BW and for each assigned a score based on a 5-point scale. The 10 criteria and the basis for scoring are shown in Table 2. The points for each criterion for approximately 30 species of pathogenic bacteria, viruses and toxins were based on data available from the literature.

By adding up the points assigned to each of the criteria for each of the bioagents (Table 2) we rated them and then divided them into three groups, according to the likelihood of their use for BW.

The first group includes the agents with a rating (combined scores)  $\geq 15$ , i.e., those that had earned more than 50% of the maximum possible ("ideal") number of points

The second group includes agents with scores  $\geq 10-14$ , i.e., with 30-50% of the "maximally possible." The third group includes the agents with less than 10 points (approximately 30% of the "maximally possible"). Given this distribution of bioagents, it follows that bioagents in Group 1 (of Table 3) are most likely to be used as BW; bioagents in Group 2 are potentially useful; and bioagents in Group 3 should not be viewed as potential BW which could cause mass disease outbreaks among humans.

This criterion-rating-based evaluation can be applied to any bioagent and not only those in Table 3. All one needs to know (or merely suppose) is what "weight" (how many points) is to be assigned to a given criterion related to using this bioagent for BW. It should be noted that of the 10 criteria for determining the likelihood of use as BW, some may be "critical" in influencing the decision one way or the other, regardless of the overall rating based on points.

For instance, the agent of syphilis cannot be cultivated and apparently cannot be transmitted by aerosol. Therefore, in spite of all other indices it should not be considered a potential BW agent.

Should the influenza virus ever be used as BW, its epidemicity and the absence of reliable prophylaxis may make it a double-edged sword that afflicts not only the enemy but also the home country's population.

Thus, the criterion-rating approach allows the grouping of bioagents by the probability of their use as BW. This should facilitate BW control and the establishment of quantitative limits for work with agents in each class. The method is simple, universal, and in essence objectively reflects the actual status of BW activities.